NAVSHIPS 92465

INSTRUCTION BOOK

for

OSCILLOSCOPE AN/USM-24C

WATERMAN PRODUCTS CO., INC.
PHILADELPHIA 25, PA., U.S.A.

DEPARTMENT OF THE NAVY
BUREAU OF SHIPS

Contract: NO *bsr 59499* *Approved by BuShips: 19 April 1955*

LIST OF EFFECTIVE PAGES

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DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
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IN REPLY REFER TO
Code 993-100
19 April 1955

From: Chief, Bureau of Ships
To: All Activities Concerned with the Installation, Operation and Maintenance of the Subject Equipment

Subj: Instruction Book for Oscilloscope AN/USM-24C, NAVSHIPS 92465

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A. G. MUMMA
Chief of Bureau

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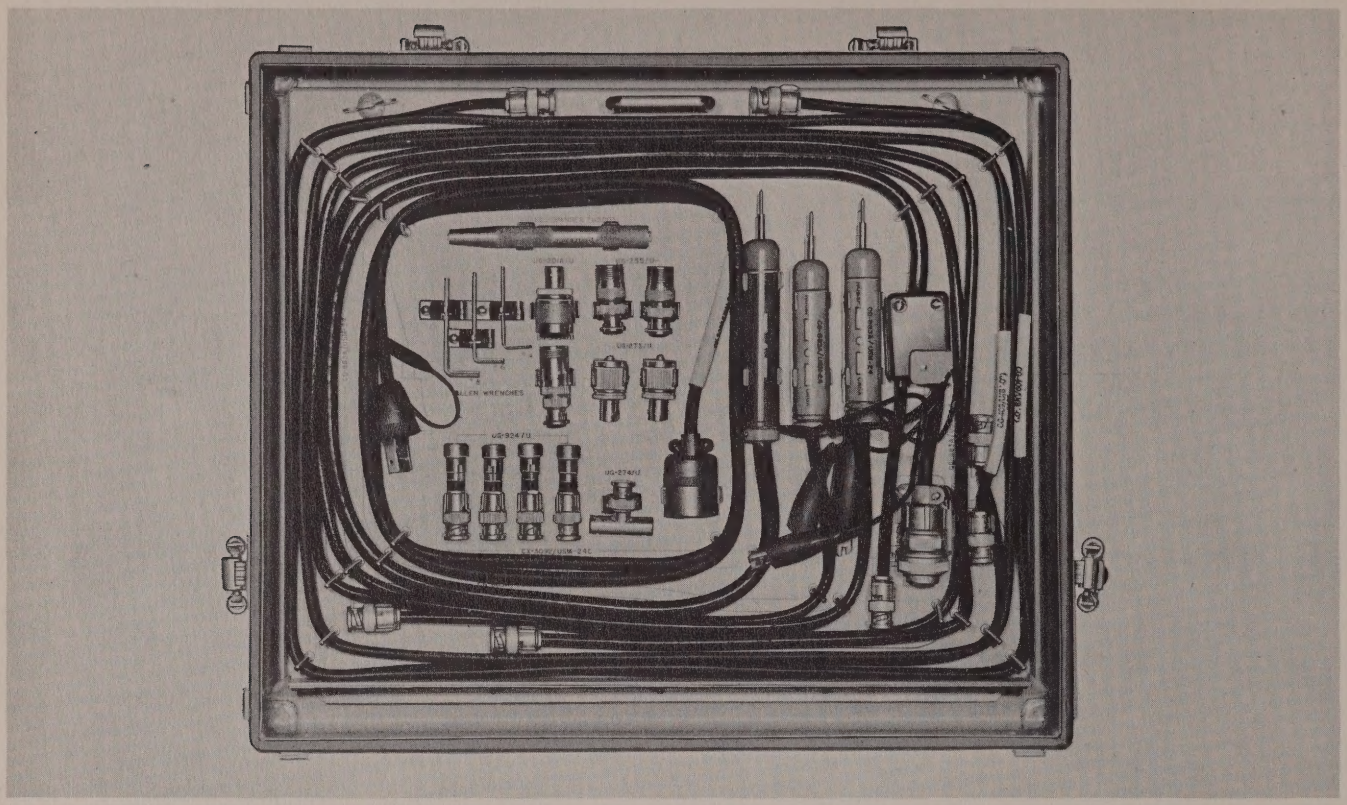


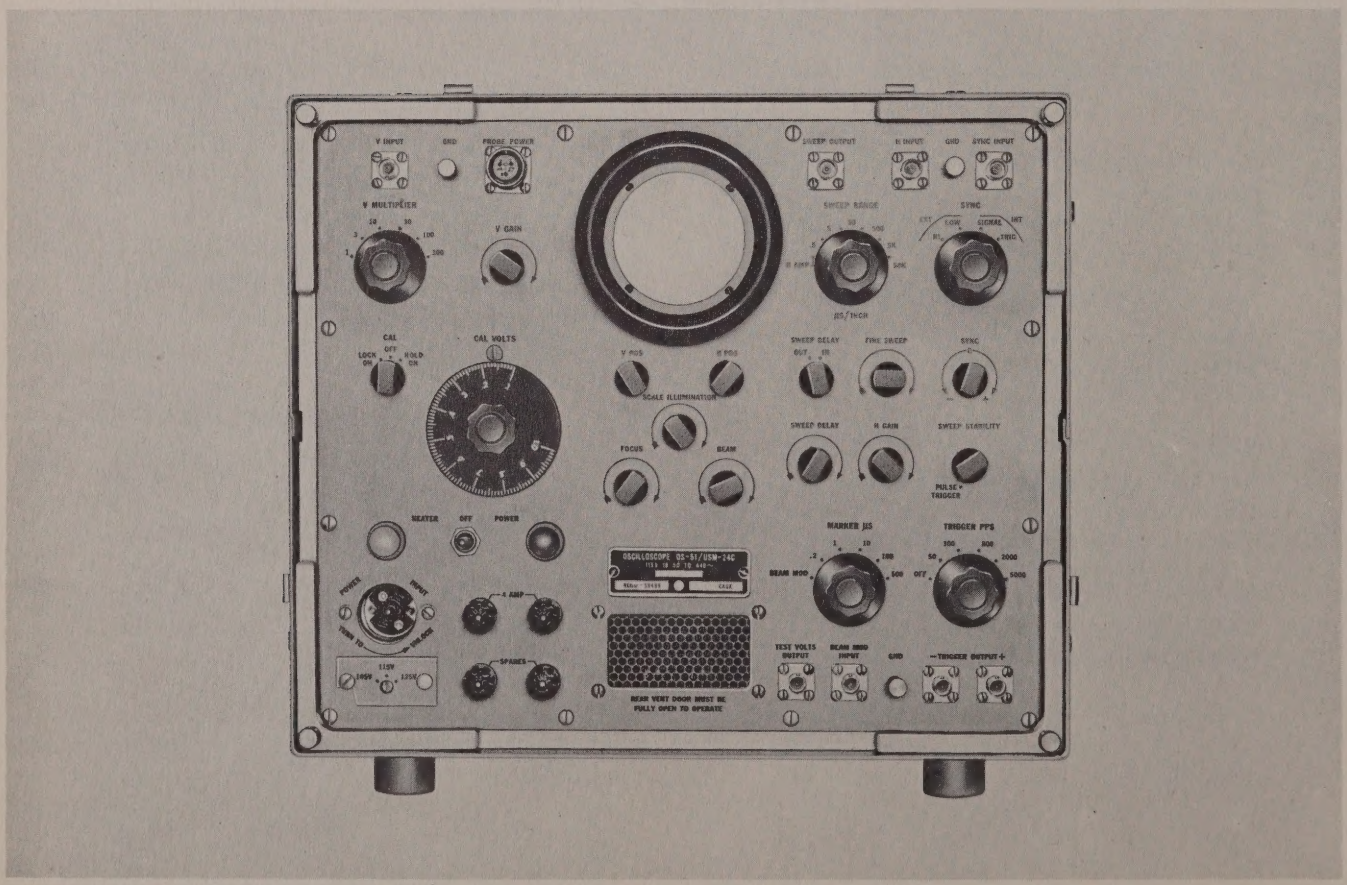


Figure 1—1. Oscilloscope AN/USM-24C

SECTION 1
GENERAL DESCRIPTION

1. PURPOSE AND BASIC PRINCIPLES.

Oscilloscope AN/USM-24C is a portable set for displaying a luminous plot of the time variation of a voltage pulse or wave, with self-contained means for measuring its duration, displacements and instantaneous magnitude of all portions of its shape. The oscilloscope is primarily intended for use in testing of all types of electronic equipment.

The equipment AN/USM-24C consists of Oscilloscope OS-51/USM-24C, Cover, Combination Case CW-362/USM-24C, and accessories mounted in the cover.

This instruction manual describes the basic principles, characteristics, operation and maintenance of the oscilloscope. The major portion of the unit is Oscilloscope OS-51/USM-24C, and therefore most of the references throughout the text will be to that unit.

2. DESCRIPTION OF UNIT.

a. Figure 1—1 shows Oscilloscope OS-51/USM-24C contained in a combination case, and Cover, Combination Case CW-362/USM-24C with mounted accessories, all combined to form Oscilloscope AN/USM-24C. The Oscilloscope OS-51/USM-24C is shown in figure 1—2. The Cover, Combination Case CW-362/USM-24C, with all accessories mounted, is shown in figure 1—3. The operational characteristics are summarized in tabular form in paragraph 4 under REFERENCE DATA. The basic principles and circuitry are described in SECTION 2. Figure 7—45 is a block diagram showing the basic functions and relationships of component circuits and controls and this block diagram will be referred to throughout the instruction manual.

b. The cathode ray tube, which portrays the signals by excitation of the screen by a moving electron beam, is three inches in diameter and is viewed head-on. The light shield assembly includes an edge-lit plexiglas graph screen and green light filter. The degree of illumination of the calibrated lines of the graph screen is easily controlled by means of the SCALE ILLUMINATION potentiometer. The viewing system has minimum ambient light interference, low parallax error, and a wide angle of view.

c. Since it is usually desirable to observe the instantaneous magnitude of electrical signals against time, the horizontal presentation is normally a linear time base. The time base may be varied at will within the limits of 0.5 to 50,000 microseconds per inch by means of a SWEEP RANGE switch and a FINE SWEEP potentiometer. Also, in sweeps over 5 microseconds/inch, any portion may be selected and expanded approximately 10 times for a more detailed observation of the signal. It is possible to operate the linear time base either periodic or aperiodic (triggered).* The H GAIN control is used to vary the length of the horizontal trace so that direct interpolation between time markers and graph screen permit observation and measurement of time periods less than those provided for by markers.

d. Observed signal amplification is uniform over a wide frequency range so that flat topped pulses may be adequately displayed. The applied signal is shown as vertical deflection. The rise time of the vertical channel is 0.07 microseconds, and tilt for a 2,500 microsecond flat topped wave is less than 5%. Sensitivity of the vertical channel is such that signals with RMS values from .014 to 155 volts may be observed directly. The lower value of .014 volts is based on a minimum deflection of ¼ inch, while the higher value is based on a maximum undistorted deflection of ¾ inch in one direction or a total of 1½ inches. Signals up to 600 volts peak may be observed in conjunction with Lead, Test CG-883A/USM-24 (10:1 attenuating probe). Signals up to 2 volts peak to peak may be observed in conjunction with Lead, Test CG-1277/USM-24C with only 11 micromicrofarads shunt capacity loading. The vertical channel includes a delay line of 0.55 microseconds, thus making it possible to observe the leading edge of a pulse triggering the linear time base. Provisions are included in the vertical channel for applying signals directly to one plate of the cathode ray tube.

e. The electron beam is energized only during trace time of the linear time base, thus providing a high degree of brightness without injury to the cathode ray tube screen. The linear time base produces a gate which intensifies the beam during trace time only. Timing markers, generated internally, are also used to produce further intensification during trace time.

f. The oscilloscope has certain important auxiliary features: a calibrating generator for accurate direct measurement of instantaneous values of signal without recourse to external standards, a choice of five time markers of 0.2, 1, 10, 100 and 500 microseconds which are synchronized with the sweep for accurate time measurements, and a trigger generator with five fixed ranges of 50, 300, 800, 2000 and 5000 pulses per second for triggering both the oscilloscope and external apparatus.

g. All operating controls and connections to the oscilloscope are on the front panel or accessible through the ventilating door at the rear of the combination case. Controls and connectors are arranged functionally and are so labelled that the oscilloscope may be operated without reference to the instruction manual after familiarization. (All accessories are mounted on the tray of the oscilloscope cover).

* Synchronization is from either internal or external source with polarity optional.

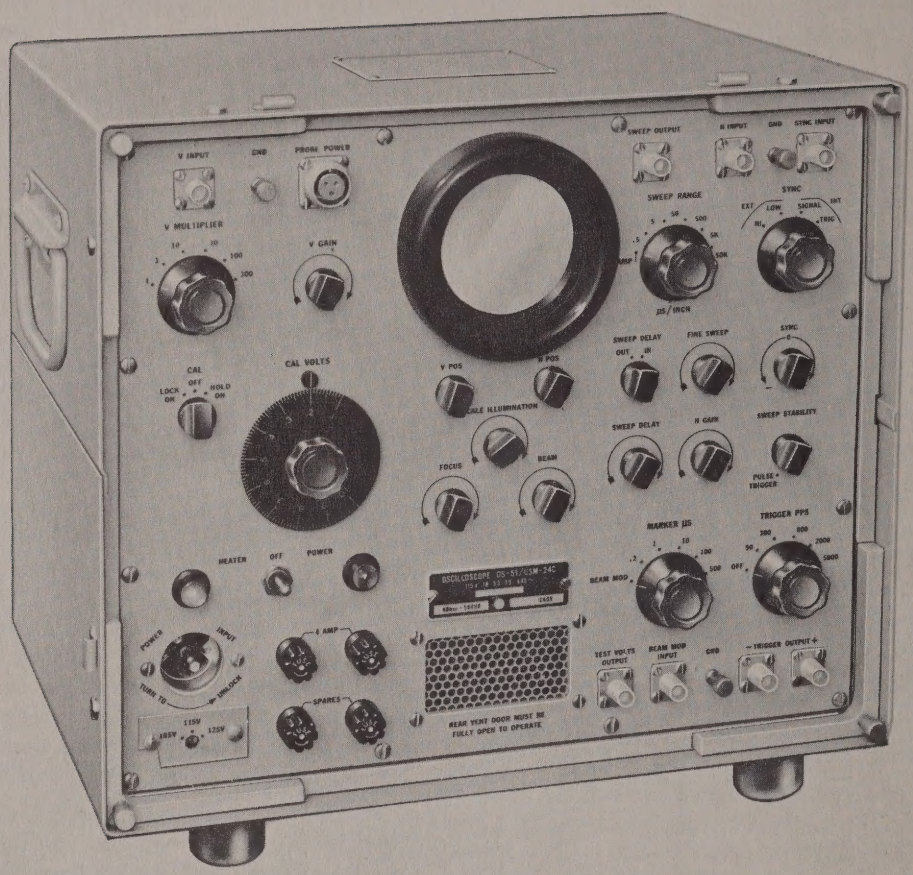


Figure 1—2. Oscilloscope OS-51/USM-24C

b. The oscilloscope is contained within a combination case, with both the front panel and the framework cradled in rubber to minimize the effects of shock and vibration on its operation. The individual chassis are interconnected by means of individual connectors and test points, so that diagnosis may be made without tools. This makes the maintenance of the oscilloscope much easier. No disassembly is necessary for diagnosing troubles that may occur.

i. The Oscilloscope AN/USM-24C is dripproof and can be stored at any temperature between —65°C (—85°F) to 85°C (185°F) for extended periods. The Oscilloscope OS-51/USM-24C is designed to operate between —54°C (—65°F) to 65°C (150°F) under humidity conditions up to 95%. Power safety interlocks protect the unit operation when the air circulation is improper and protect the operator when the unit is uncased. An internal fan is thermostatically controlled to provide quick warmup at the start and a subsequent constant operating temperature. However, under humidity conditions in the range of 75% to 95% the HEATER should be turned on when the oscilloscope power is not in "POWER" position. The oscilloscope is extremely well-filtered to minimize RF interference to adjacent and nearby electronic equipment. The oscilloscope is well shielded and filtered so that external electrostatic and electromagnetic fields as well as conducted noise on the power line do not cause misoperation of the oscilloscope. The oscilloscope may be used in altitudes up to 10,000 feet, and will take any reasonable shock and vibration imposed on it by normal usage.

j. The Oscilloscope AN/USM-24C is a miniaturized oscilloscope, characterized by light weight, small size

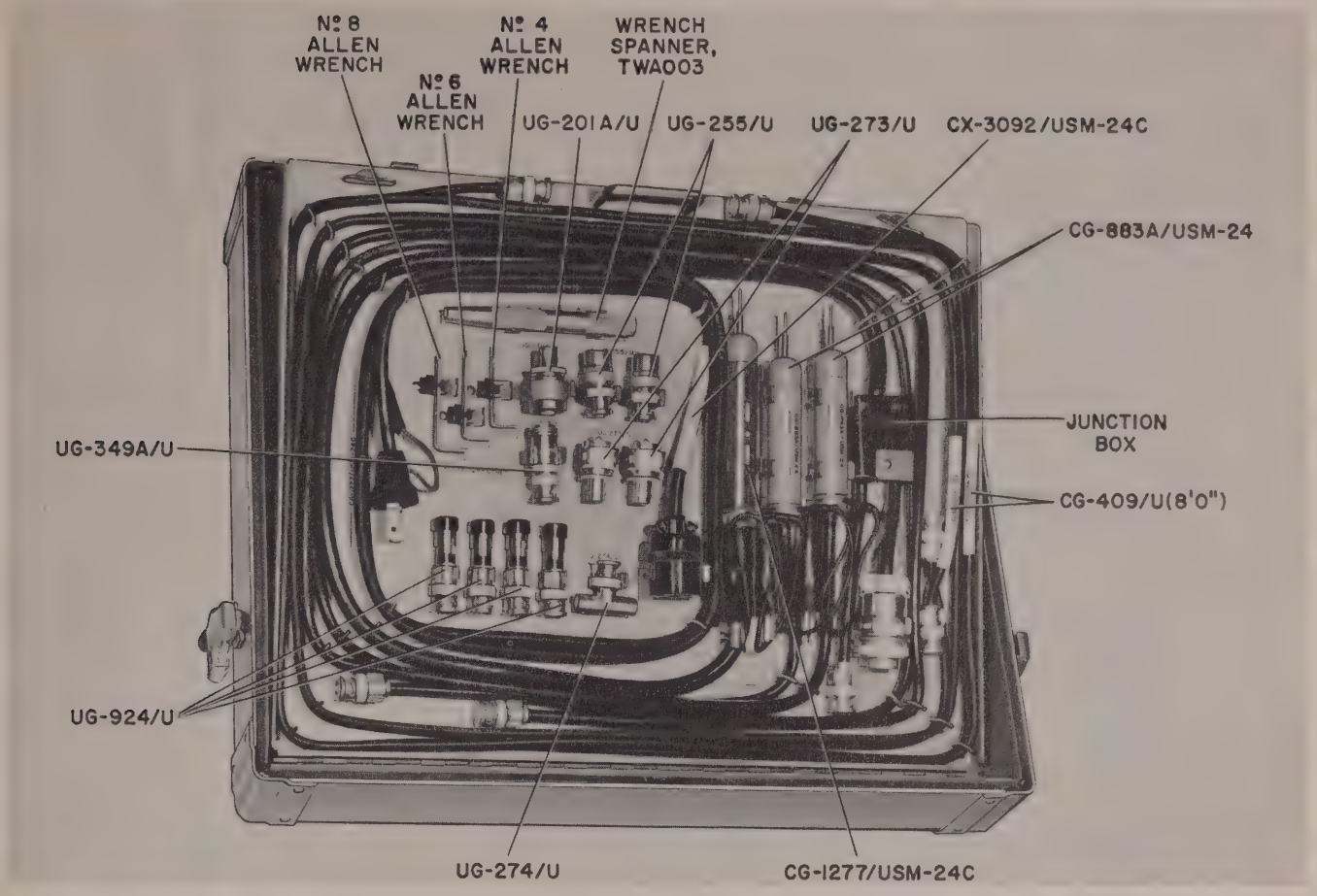


Figure 1—3. Cover, Combination Case CW-362/USM-24C with Accessories Mounted

and a high degree of electrical performance. The lay-out of controls and connectors, together with the choice of accessories, make it a versatile and easily operated piece of equipment. In spite of its small size the oscilloscope is easily serviced.

3. DESCRIPTION OF ACCESSORIES.

a. All accessories are mounted in Cover, Combination Case CW-362/USM-24C. Figure 1—3 shows all accessories as mounted.

b. The Power Cable CX-3092/USM-24C is a six foot 3 conductor cable for connecting the oscilloscope to a source of power. It is terminated at one end with a 3 pole twist-lock connector to mate with the connector on the oscilloscope. The power line plug is at the other end and is a standard parallel blade connector with a flexible ground connection extending from the side of its rubber body and is used to ground the equipment for safety of operating personnel.

c. Two test leads CG-409/U (8′0″) consist of eight feet of coaxial cable RG-58/U terminated at both ends with UG-88/U BNC connectors for inter-connection between oscilloscope and test or signal points on other equipment.

d. Two test leads CG-883A/USM-24 are attenuating cables with low input capacity and 10 to 1 attenuation. They are used to make connections between sources of signal and the oscilloscope.

The shunt impedance of Cable CG-883A/USM-24 is 15 micromicrofarads and 3.0 megohms. The cable is 52 inches long, and is terminated by a connector UG-260/U on one end, and an attenuating housing on the other end. The termination of the attenuating housing is a probe tip which may be replaced by any attachment with a 6-32 thread. A ground lead with an insulated alligator clip is attached to the attenuator housing.

e. Test Lead CG-1277/USM-24C is a cable assembly with an integral grounded plate amplifier with low loss and low input capacity. It is used for connecting to sources of low signal level which will not tolerate loading. The input impedance of test lead CG-1277/USM-24C is one megohm paralleled by 11 micromicrofarads. Terminating connectors to the oscilloscope are types UG-260/U and AN-3106A-14S-7P connectors. The housing for the amplifier is similar to that used on CG-883A/USM-24 and has a similar ground lead.

f. Two adapters UG-255/U for mating between BNC female connectors and UHF male connectors are supplied.

g. Four adapters UG-924/U which are binding post adapters to fit BNC female connectors are supplied.

h. Two adapters UG-273/U for mating between BNC male connectors and UHF female connectors are supplied.

i. Adapter UG-274/U, which is a T connector for mating between one BNC female connector and two BNC male connectors is supplied.

j. One adapter UG-201A/U for mating between N female connector and BNC male connector is supplied.

k. One adapter UG-349A/U for mating between N male connector and BNC female connector is supplied.

l. Three Allen wrenches No. 4, No. 6, and No. 8 are supplied for set screws used in knobs, couplings, etc.

m. One spanner wrench, Waterman Products Co., Inc., part No. TWA003-002 for test leads and for special nuts on front panel (under knobs) is provided.

n. A Cover, Combination Case CW-362/USM-24C is provided. It consists of the cover, with attached schematic diagram and storage space for one instruction manual under a tray which is used for mounting all accessories.

4. REFERENCE DATA.

The following four tables summarize all pertinent information on the AN/USM-24C Oscilloscope.

TABLE 1—1. EQUIPMENT SUPPLIED AN/USM-24C

QTY. PER EQUIP.	NAME OF UNIT	NOMENCLATURE	OVER-ALL DIMENSIONS IN INCHES	VOL. IN CUBIC FEET	WT. LBS.
1	Oscilloscope	AN/USM-24C	17 11/32 wide x 14 13/16 high x 14 7/8 deep	2.2	58.0
1	Oscilloscope	OS-51/USM-24C	17 5/32 wide x 14 15/32 high x 12 19/64 deep	1.8	50.5
1	Cover, Combination Case	CW-362/USM-24C	17 11/32 wide x 14 3/16 high x 2 25/32 deep	0.4	4.25
*1	Cable, Power	CX-3092/USM-24C	72 long x 1 5/32 O.D.		3/8
*2	Lead, Test	CG-409/U (8′ 0″)	96 long x 27/64 O.D.		9/16
*2	Lead, Test	CG-883A/USM-24	58 long x 13/16 O.D.		5/8
*1	Lead, Test	CG-1277/USM-24C	42 3/4 long x 1 1/4 O.D.		1/2
*2	Adapter	UG-255/U	1 3/8 long x 5/8 O.D.		1/8
*4	Adapter	UG-924/U	1 13/16 long x 9/16 O.D.		3/16
*1	Adapter	UG-274/U	1 9/32 x 1 1/16 x 9/16		1/16
*2	Adapter	UG-273/U	1 5/16 long x 11/16 O.D.		1/8
*1	Adapter	UG-201A/U	1 5/16 long x 13/16 O.D.		1/16
*1	Adapter	UG-349A/U	1 9/16 long x 5/8 O.D.		1/16
*1	Wrench, Allen No. 4		1 13/16 x 5/8 x 3/64		
*1	Wrench, Allen No. 6		1 13/16 x 5/8 x 1/16		
*1	Wrench, Allen No. 8		1 15/16 x 11/16 x 5/64		
*1	Wrench, Spanner TWA003		4 1/8 long x 7/16 O.D.		1/16
**2	Instruction Book	NAVSHIPS (92465)	11 1/2 x 8 3/4		3 1/2

*Mounted in cover CW-362/USM-24C.

**One book is contained in cover CW-362/USM-24C, the other is packed in the shipping container.

TABLE 1—2. SHIPPING DATA

SHIPPING BOX NO.	CONTENTS NAME	DESIGNATION	OVER-ALL DIMENSIONS IN INCHES			VOL. CU. FT.	WT. LBS.
			HEIGHT	WIDTH	DEPTH		
1	OSCILLOSCOPE	AN/USM-24C	22¼	24½	19½	6.15	117
2	NAVY EQUIPMENT SPARE	AN/USM-24C	11	10¼	9	0.59	10

TABLE 1—3. ELECTRON TUBE COMPLEMENT

UNIT	NUMBER OF TUBES OF TYPE INDICATED											
	JAN-0A2WA	1V2	JAN-3JP1	JAN-6AH6	JAN-6AN5WA	JAN-12AT7WA	JAN-12AU7	JAN-5719	JAN-5726	JAN-6135	6203	TOTAL NO. OF TUBES
DISPLAY CHANNEL			1									1
VERTICAL CHANNEL				2	2		2					6
HORIZONTAL CHANNEL							2					2
LINEAR TIME BASE CHANNEL						1½	2		1			4½
SYNCHRONIZATION CHANNEL						1½			1			2½
INTENSITY CHANNEL				1		2				2		5
TRIGGER GENERATOR							1					1
POWER SUPPLY CHANNEL	1	2									4	7
ACCESSORIES								1				1
TOTAL NO. OF EACH TYPE	1	2	1	3	2	5	7	1	2	2	4	30

TABLE 1—4. REFERENCE DATA

a. Nomenclature	Oscilloscope AN/USM-24C
b. Contract Number	NOBsr-59499
c. Contractor	Waterman Products Co., Inc., Philadelphia 25, Pa.
d. Cognizant Naval Inspector	Inspector of Naval Material, Philadelphia, Pa.
e. Number of packages per complete shipment of equipment	Without equipment spares—one. With equipment spares—two

TABLE 1—4. REFERENCE DATA—Continued

f. Cubical contents	
equipment crated	24½ wide x 22¼ high x 19½ deep
equipment uncrated	17 11/32 wide x 14 13/16 high x 14⅞ deep
equipment spares uncrated	10¼ wide x 11 high x 9 deep
Oscilloscope OS-51/USM-24C	17 5/32 wide x 14 15/32 high x 12 19/64 deep
g. Weight	
equipment crated	117 pounds
equipment uncrated	58 pounds
equipment spares uncrated	10 pounds
Oscilloscope OS-51/USM-24C	50.5 pounds
h. Vertical channel	
Sine wave response	Flat within −3db from 2 cycles to 6 megacycles per second Flat within −6db from 1½ cycles to 8.5 megacycles per second
Transients response	0.07 microseconds rise
Low frequency tilt	Less than 5% for 200 cycle square wave
Polarity	Positive for upward deflection—Negative for downward deflection
Delay	0.55 microseconds (fixed)
i. Input impedance	
V INPUT	300,000 ohms paralleled by 40 micromicrofarads
V INPUT through test lead CG-883A/USM-24	3.0 megohms paralleled by 15 micromicrofarads
V INPUT through test lead CG-1277/USM-24C	1.0 megohm paralleled by 11 micromicrofarads
V PLATE	2.2 megohms paralleled by 14 micromicrofarads
H INPUT	6.2 megohms paralleled by 47 micromicrofarads
SYNC INPUT	300,000 ohms paralleled by 35 micromicrofarads
SYNC INPUT through test lead CG-883A/USM-24	3.0 megohms paralleled by 15 micromicrofarads
BEAM MOD	56,000 ohms paralleled by 39 micromicrofarads

j. Output Voltage and Load Impedance	Volts Peak to Peak	Minimum Resistance Ohms	Maximum Capacity μμfd
SWEEP OUTPUT	20	50K	100
TEST VOLTS OUTPUT	20	250K	100
TRIGGER + or −	25 to 50	500	500

k. Input Sensitivity and Voltage Limits	Minimum Sensitivity RMS	Peak Volts# Maximum	Total Peak Volts# (Signal Plus DC)	
V INPUT	0.06*	150	400	#Plus or minus unless otherwise stated
V INPUT through test lead CG-883A/USM-24	0.6*	600	600	
V INPUT through test lead CG-1277/USM-24C	0.096*	2	400	*RMS Volts per inch

TABLE 1—4. REFERENCE DATA—Continued

V PLATE	39.0*	150	+600 −150
H INPUT	3.6*	67	400
SYNC INPUT	0.5	150	150
SYNC INPUT through test lead CG-883A/USM-24	5.0	450	600
BEAM MOD	1.5	75	400

l. Sweep time	0.5 μs to 50,000 μs per inch, continuously adjustable, for 2½ inch trace
m. Sweep circuit	Variable trigger or periodic and fixed pulse trigger.
n. CALibration	0.1 to 1 volt pp of 5KC square wave for calibrating signal amplitude. 20 volts ±20% of same available at front panel (J-3) for external use
o. Timing markers	Synchronized with sweep and available at intervals of 0.2, 1, 10, 100, or 500 microseconds
p. Trigger pulse output	25 to 50 Volts, approx. 1.6 microseconds wide pulse having rise time of 0.1 microseconds, occurring at 50, 300, 800, 2000 or 5000 times per second
q. Sweep delay and expansion	Any portion of sweep over 6 μs per inch may be delayed and expanded approximately 10 times for detailed examinations of the vertical signal
r. Measuring scale	25 x 15 divisions, very low parallax, and illuminated with complete control of brightness even to extinction
s. Cathode Ray Tube Screen Diameter	3 inches
t. Cathode Ray Tube Display	1½" undistorted vertical deflection (¾" for unidirectional signals such as pulses)
Accelerating Potential	3000 volts
u. Power supply Volts	100 to 130 with proper setting of S-8
Frequency	50 to 400 cycles per second
Wattage	220 watts at 115 volts 60 cycles
v. Ambient temperature limits	−54°C (−65°F) to 65°C (150°F)
w. Maximum relative humidity	Over 95%
x. Altitude	Approximately 10,000 ft. (barometric pressures down to 20.6 in.)
y. Effect of microwave fields	Virtually none
z. Radio interference	Conducted and radiated interference between 14KC and 1000MC well below the limits of military specification MIL-I-16910 (SHIPS)

SECTION 2
THEORY OF OPERATION

1. BASIC PRINCIPLES.

An oscilloscope is an instrument for portraying a luminous plot of instantaneous voltages against a time base. The basic principles and circuits are described in this section. The complete block diagram, figure 7—45, and the complete schematic, figure 7—46 is included in section 7, and is referred to herein. The oscilloscope consists basically of the following nine elements:

Display Channel	Synchronization Channel
Vertical Channel	Intensity Channel
Horizontal Channel	Trigger Generator
Linear Time Base Channel	Power Supply Channel
	Accessories

a. The heart of the display channel is the cathode ray tube, which is a device for producing an electron beam of variable intensity, with means for deflecting the beam in both horizontal and vertical directions, and a fluorescent screen for transforming the electron beam into visible light. The persistence of the screen material coupled with the retentivity of the human eye, in effect, produce a sensation of a line when a spot is moved on the screen. This phenomenon makes the cathode ray tube an ideal device for observation of electrical waves.

b. The vertical channel consists of an amplifier with suitable pass band and gain to handle the desired input signal. The attenuator together with the gain control permit observation of signals varying widely in magnitude.

Time delay is provided in the vertical channel in order to permit other circuits, such as the linear time base, intensification and markers to start before the vertical signal reaches the screen of the cathode ray tube. Signals of positive and negative going nature are handled here. The vertical channel includes an internal sync take off, prior to signal delay, which provides a source of incoming signal for the synchronization of the linear time base channel. It also includes a calibration generator which consists of a 5KC square wave generator. Its function is to provide a signal to the vertical pre-amplifier for measuring the amplitude of the incoming signal. An additional function is to provide a test signal for general purpose external uses and for checking functions of the oscilloscope and accessories.

c. The horizontal channel consists of an amplifier with suitable pass band and gain to amplify sweep voltages produced by the linear time base. Only positive going signals are handled from this source. In order to maintain the quiescent spot at a fixed point on the display tube screen, suitable clamps are provided. Means are provided for handling external positive going or symmetrical, periodic signals.

d. The linear time base channel provides a proper time base so that the signal trace appears in conventional form. To make the oscilloscope adaptable for observation and measurement of signals varying widely in duration and rate of occurrence, provisions are made for varying the trace in terms of time. The oscilloscope is designed so that portions of the trace can be selected and expanded approximately 10 times for closer observation and measurement.

e. The synchronization channel provides means for synchronizing the linear time base channel with the signal so that the trace appears stationary on the face of the cathode ray tube. The circuitry is such that the linear time base can be synchronized with the incoming signal, the internal trigger generator or with an external synchronizing signal of either polarity.

f. The intensity channel provides the modulation of the electron beam, producing a light output variation of the spot. The most desirable operation is intensification during trace time of the linear time base. Therefore, intensification is produced in this oscilloscope with a positive going gate being applied to the grid, and a negative going marker signal being applied to the cathode of the display tube.

g. The trigger generator is basically a pulse generator whose occurrence rate may be varied in five steps from 50 to 5000 pps. The purpose of the trigger generator is to provide a trigger for the oscilloscope and also external equipment. The pulse is approximately 1.6 microseconds in duration, with a rise time of 0.1 microseconds and an amplitude of 25 to 50 volts peak.

h. The power supply channel provides all the necessary voltages required for the operation of the oscilloscope as well as power for the ventilating system.

i. The accessory probes are CG-883A/USM-24 and CG-1277/USM-24C. Both of these probes have low input capacity. The CG-883A/USM-24 has a 10 to 1 attenuation while the CG-1277/USM-24C is a low loss probe. The sum of the peak signal and the DC voltages applied to the CG-883A/USM-24 should not exceed 600V. The signal voltage impressed on the CG-1277/USM-24C should not exceed 2 volts peak to peak, and the total DC voltage should not be greater than 400V.

2. DISPLAY CHANNEL.

a. The display channel consists of a cathode ray tube with a series of controls for static adjustments

and with means for trace calibrations. The simplified schematic is shown in figure 2—1.

b. The cathode ray tube shown schematically in figure 2—1 is the heart of the oscilloscope. In modern oscilloscopes, such as this one, electrostatic focus and deflection type cathode ray tubes are used. The cathode ray tube consists of an electron gun, deflection plates, and luminescent screen, all contained within an evacuated envelope.

(1) The electron gun has a heater for raising the temperature of the cathode emitting surface to the correct level. Electrons are attracted by the second grid (G2 bottom) which is at a high positive potential with respect to the cathode (K). The control grid (G1) which is at a negative potential, regulates the amount of electrons or intensity of the electron beam moving towards the second grid (G2 bottom). These three elements form a lens which focuses the beam into the aperture of the second grid. This lens system is similar to the "thick" lens system as used in optics. A crossover occurs shortly after the first grid (G1).

(2) The divergent beam entering G2 bottom is masked off by the aperture of G2 top. A second lens consisting of G2 top, first anode (A1) and second anode (A2) is similar to the "thin" lens system as used in optics. This lens is a convergent lens, focusing the electron beam on the luminescent material on the face of the tube. G2 top and A2 are connected together electrically to a high positive voltage. A1 is connected to a much lower positive voltage. The voltage on A1 determines the focal length of the system, thus variations of voltage on A1 is used to focus the beam.

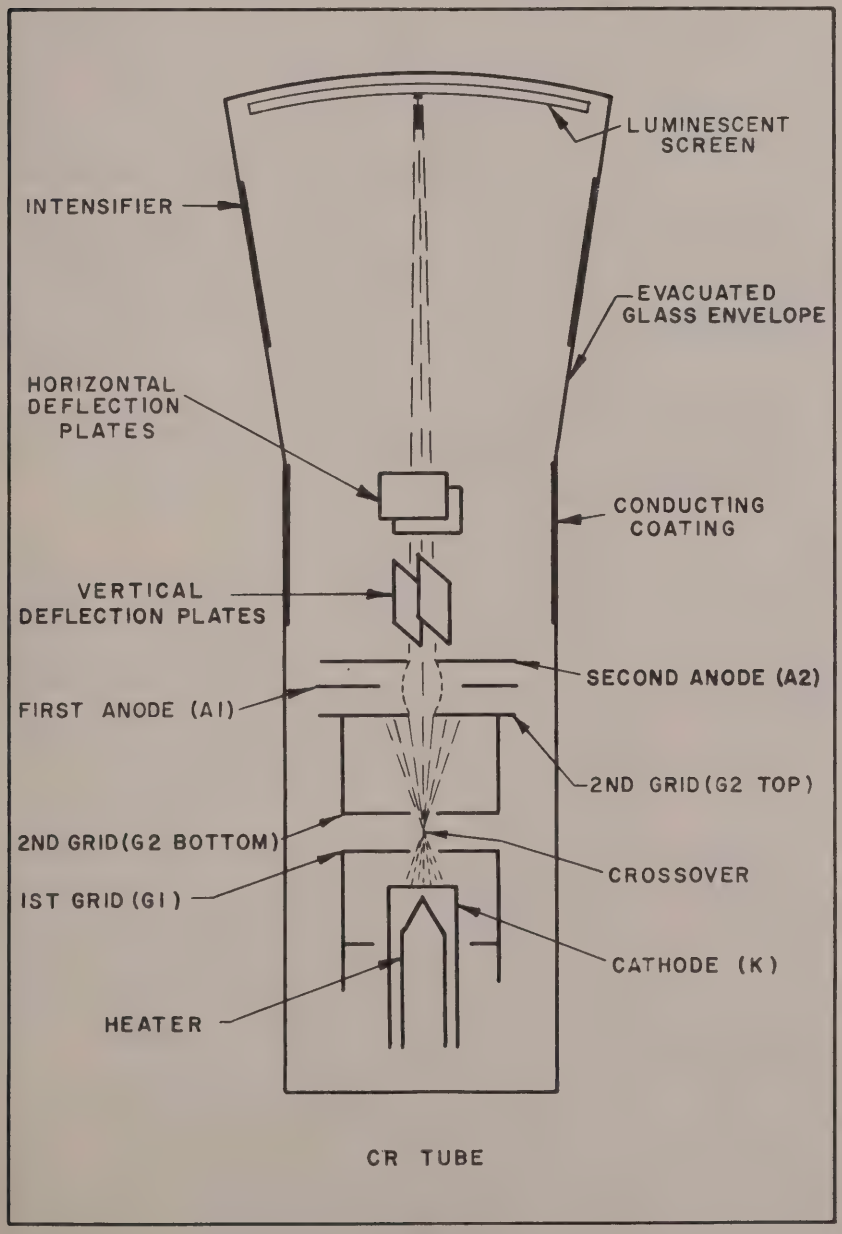


Figure 2—1.
Cathode Ray Tube—Schematic

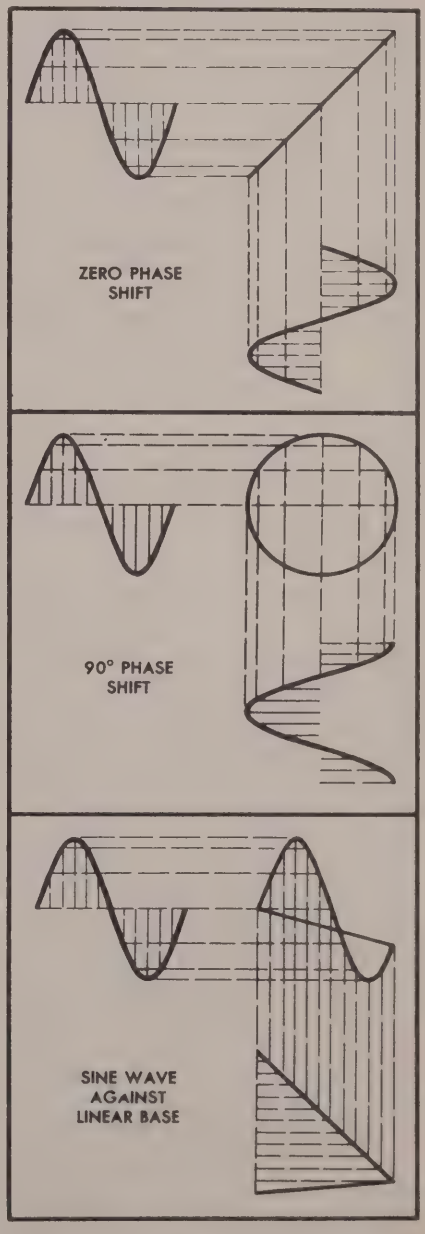


Figure 2—2.
Wave Forms—Vector Plotting

(3) The electron beam passing between the deflection plates will be bent towards the plate with the higher positive potential. Since two pairs of deflection plates are at right angles to each other, the electron beam can be deflected along the X and Y axis. The average potential between each pair of deflecting plates is normally equal to the second anode voltage, otherwise the beam will become defocused.

(4) The convergent beam strikes the luminescent material which emits secondary electrons. These are collected by the conductive coating on the side of the tube, thus completing the electrical circuit.

(5) For viewing transients, where light output requirements are severe, higher beam velocities are required. This normally is obtained by post-deflection acceleration. A ring of conductive material is deposited between the conductive coating and the luminescent material on the screen. This ring is known as an intensifier and is connected to a source of voltage higher than that of the second anode.

(6) When the electron beam strikes the luminescent screen, the screen emits visible light, the magnitude of which is proportional to the intensity of the electron beam. Emission of visible light during electron excitation commonly is called fluorescence, while the afterglow is called phosphorescence. The duration of the phosphorescence is called the persistence of the screen. In this oscilloscope, a JAN 3JP1 (V6) is used. The P1 screen is green in color and is of medium persistence.

(7) The persistence of the screen material and the retentivity of the human eye in effect produce the sensation of a line when the spot is moved on the screen. Figure 2—2 shows the visible trace as it appears on the face of the cathode ray tube under the listed conditions.

(8) Figure 2—2 shows the visible trace as it appears on the face of the cathode ray tube under the conditions listed below. The figure in the upper left portion of each illustration represents the vertical signal, the figure in the lower right portion represents the horizontal deflection signal and the figure in the upper right represents the resultant or the vector of the two forces and is the visible trace on the cathode ray tube screen.

(a) Two sine waves of equal frequency and of the same phase are shown in figure 2—2a.

(b) Two sine waves of equal frequency and 90° phase shift are shown in figure 2—2b.

(c) A sine wave against a voltage rising uniformly with time is shown in figure 2—2c.

c. For static setting of all the attributes of the electron beam, and its effect on the screen material, various controls are used, see figure 2—3.

(1) The vertical output amplifier is AC coupled to the deflection plates, pins 7 and 8. Vertical POSitioning is achieved by means of a dual potentiometer, R51A/B, which produces a difference of voltage on the deflection plates.

(2) Potentiometer R50, the astigmatism adjustment, is used to adjust the average potential of the vertical deflection plates to that of the horizontal deflection plates.

(3) The horizontal output amplifier is DC coupled to the deflection plates, pins 10 and 11, in figure 2—3. Varying the bias on V29B, by means of Horizontal POSitioning control (R196) changes the plate voltages of V29A/B, while substantially maintaining the average DC voltage.

(4) Potentiometer R66, the second anode adjustment, is set for the average potential of the deflection plates.

(5) Potentiometer R62, the BEAM control, is used for setting the beam current for the desired trace intensity.

(6) Potentiometer R58 is the FOCUS control and is used for obtaining the sharpest trace on the screen. Since a JAN 3JP1 is of "zero anode current" construction, readjustment is required only for the most precise readings.

(7) A plexiglas graph screen and green light filter are mounted in front of the cathode ray tube. The graph is engraved on the side facing the tube so that parallax error is minimized. Two pilot lights DS3 and DS4 (figure 7—20) edge light the screen. Potentiometer R98 varies the brightness of these pilot lights so that the graph can be made brighter or dimmer as desired. Switch S9, part of potentiometer R98 assembly, cuts off all power to the pilot lights for complete dimming. The green filter in front of the plexiglas removes reflections in the presence of ambient light, thus making the trace on the cathode ray tube appear brighter.

3. VERTICAL CHANNEL.

a. The function of the vertical channel is to convey the signal from the input jack to the cathode ray tube with no appreciable change in its wave form, but with control over its magnitude in order to properly handle the wide range of signals to be observed. The signal must also be delayed by sufficient time so that the linear time base, marker, and intensity channels may start functioning before the signal reaches the cathode ray tube. A means of calibrating the amplitude of the incoming signal is provided. An internal sync take off is also provided.

(1) As shown in the block diagram, figure 7—45, the vertical channel includes a calibrated V MULTIPLIER, a preamplifier, delay line circuit, intermediate amplifier, output amplifier, means for controlling the gain of the channel plus a calibration generator and an internal sync take off.

(2) Figure 2—4 shows the voltage level diagram for the vertical channel. Signals from 0.014 RMS (¼" deflection at full gain) to 155 volts RMS (¾" undistorted deflection at maximum attenuation) can be coupled directly to the input jack. Signals from 12½ to 150 volts peak can be connected directly to the deflection plate of the cathode ray tube through the V

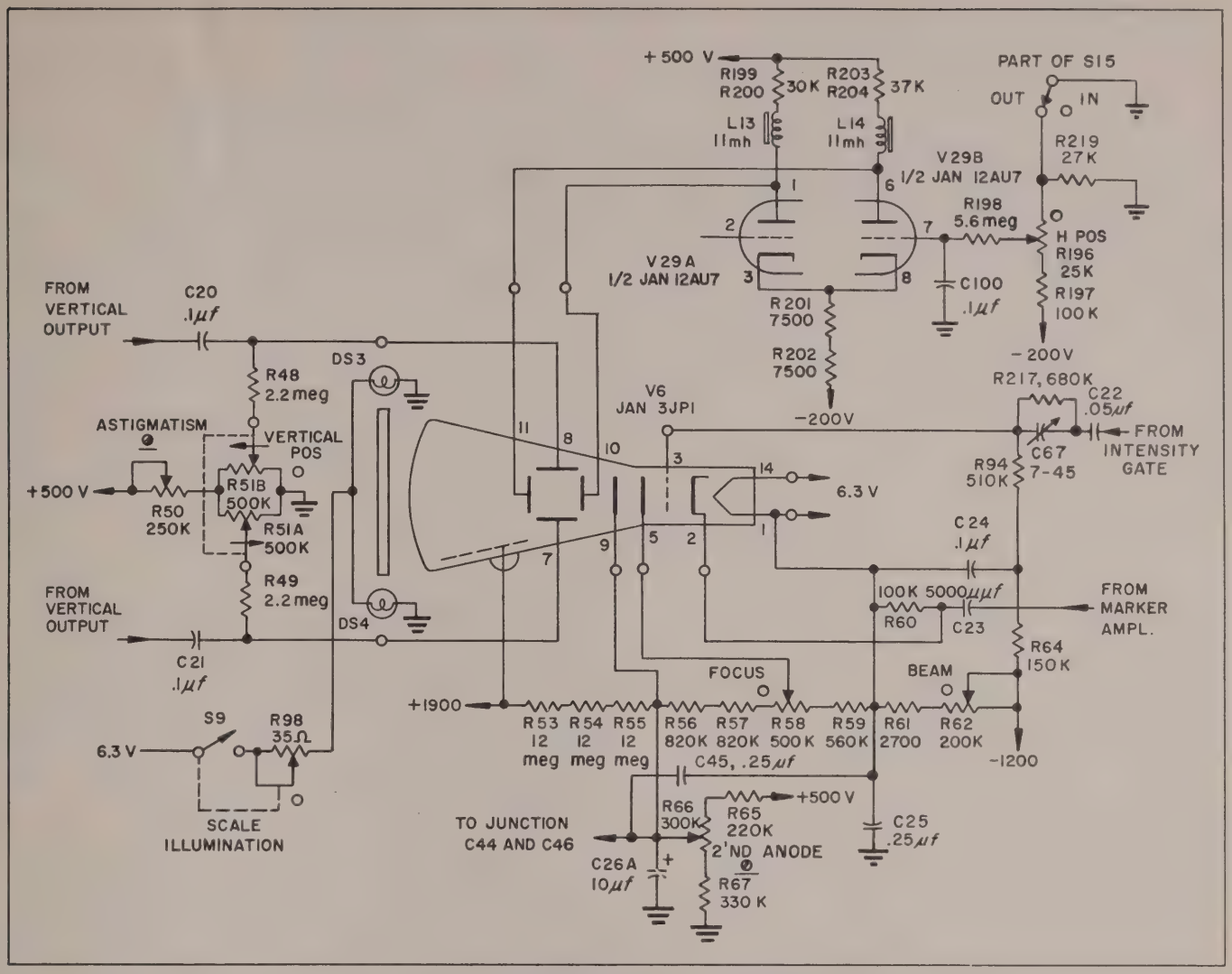


Figure 2—3. Display Channel—Simplified Schematic

DIRECT terminal in the back of the oscilloscope. A typical frequency response curve for the vertical channel is given in figure 2—5.

b. V MULTIPLIER.

The V MULTIPLIER circuit is shown in figure 2—6. The top figure shows the connections for the V MULTIPLIER at position 1, while the lower figure shows the circuit for all other positions. The circuit is such that the impedance is constant for all positions of the selector switch. The input impedance is 300,000 ohms shunted by less than 40 micromicrofarads. The V MULTIPLIER is frequency compensated so that no distortion of signal occurs within the pass band of the vertical channel. The switch has six positions: 1, 3, 10, 30, 100, and 300.

The amplitude of the input signal may be measured by substituting a variable calibrated voltage for the signal voltage present across resistor R12 (input voltage to vertical preamplifier V1). This is accomplished by CALibration switch S2. In the center or OFF position, the calibration generator voltage is grounded and the vertical preamplifier, V1, is connected to the Vertical INPUT jack, J1, via the Vertical MULTIPLIER switch. When the CALibration switch is actuated to either side of center, the preamplifier input is reconnected to the calibration generator voltage. This voltage is accurately calibrated and indicated on the CAL VOLTS dial. (See Section 2, par. 3f). Thus, when the CAL VOLTS dial is rotated to a position where the vertical deflection (on the display tube) is equal to the deflection produced by the input signal, the CAL VOLTS dial reading is the amplitude of the input signal. When the Vertical MULTIPLIER is at a position other than 1, the input signal reaching the preamplifier has been attenuated by that amount.

Therefore, the input signal amplitude is equal to the CAL VOLTS dial reading multipled by the Vertical MULTIPLIER setting. For more detailed operating information see Section 4.

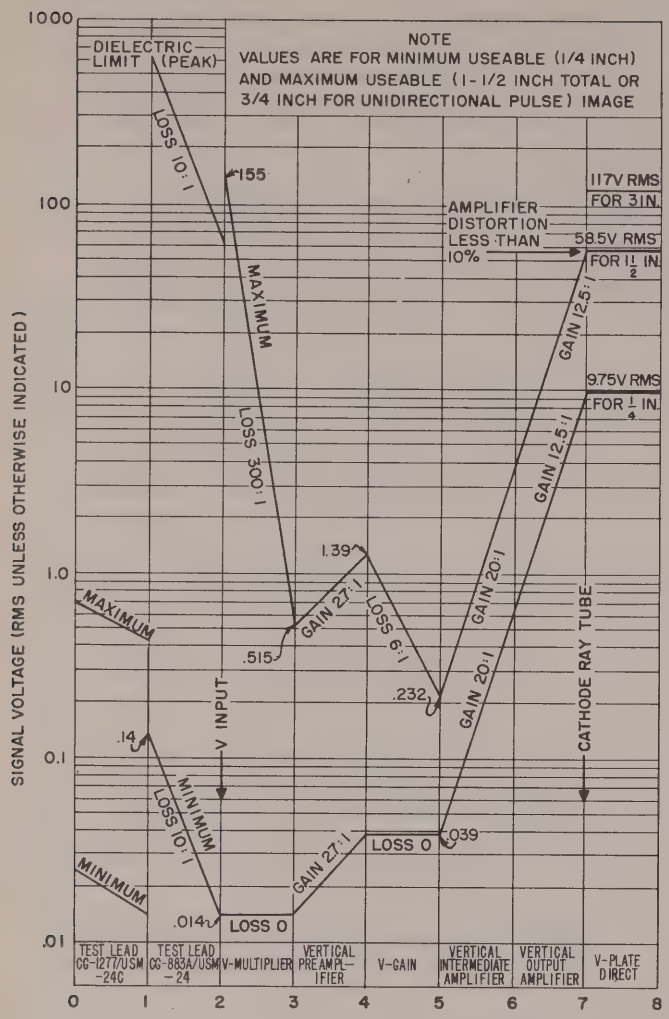


Figure 2—4. Typical Voltage Level Diagram

c. PRE-AMPLIFIER AND INTERNAL SYNC TAKE-OFF.

Figure 2—7 shows the VERTICAL PRE-AMPLIFIER, DELAY LINE DRIVER AND INTERNAL SYNC TAKE-OFF. The pre-amplifier V1, a JAN 6AH6 pentode, is RC coupled. Its output capacity is compensated for by peaking coil L1. The B supply is isolated by a decoupling network consisting of capacitors C14A and C37 and resistors R23 and R215. The screen is decoupled by bypass capacitor C103B and resistor R15. The cathode resistor R16 is bypassed by a low value capacitor C12 to peak the high frequency response. The gain of the combined pre-amplifier and delay line circuit stage is approximately 2.7. The delay line driver V2B, 1/2 12AU7 duo-triode, is a cathode follower with bias so adjusted that the same magnitude of signal of either polarity will have the same linearity characteristics. As a cathode follower it permits a proper impedance match to the low input impedance of the delay line (1,000 ohms). Because of this low impedance, a large coupling capacitor C16 is used for proper coupling of low frequencies. Resistor R24 in series with coil L16 is used to maintain a constant input impedance to the delay line. The delay line is a constant K, pi filter type, containing 50 sections. The overall delay is 0.55 microseconds with a constant phase shift. The delay line is terminated by a coil, L15, in series with a wire wound potentiometer R25 and a limiting resistor, R26. The inductance of the coil and the wire wound potentiometer maintain a constant termination impedance. R25 functions as the Vertical GAIN control, and the range of the gain control is 6 to 1. The internal sync take off is V2A, 1/2 JAN 12AU7 duo-triode, whose output is fed to the sync selector switch. The signal is reversed by 180° at this stage, and as the input signal was previously reversed in the pre-amplifier stage, the resultant signal going to the sync selector switch is in phase with the incoming signal.

d. INTERMEDIATE AMPLIFIER.

The intermediate amplifier is shown in figure 2—8. It consists of V3, a JAN 6AH6 pentode, which is RC coupled. It is fed from the gain control. Phase reversal is 180°, thus restoring the signal back to its original phase. Peaking coil L2 compensates for the output capacity of the tube. The tube is operated as "zero bias"; the cathode being returned directly to ground. Bias is developed by the contact potential across the grid resistor R27. This manner of operation gives good gain and low frequency response without the need for large values of cathode bypass capacitors. A decoupling network, capacitor C103A, and resistors R31 and R32 is used in the plate voltage supply. The gain of the stage is approximately 20.

e. VERTICAL OUTPUT AMPLIFIER.

Figure 2—9 shows the vertical output amplifier. The amplifier consists of V4 and V5, two JAN 6AN5WA pentodes. They are operated in push pull. The signal from the intermediate amplifier appears on the grid of V4, causing a signal of the same polarity to appear on its cathode. Since the cathode of V4 and V5 are tied together, the same signal appears on the cathode of V5. The grid of V5 is AC grounded through capacitor C19, and thus the tube is driven by the modulation on its cathode, and its output is 180° out of phase with that of V4. Bias is provided by resistor R36. Shunt and series peaking are used to compensate for capacity loading. The output of both plates are AC coupled to the vertical deflection plates. The circuit is so connected that positive going signal at the input jack appears as positive going trace on the screen of the cathode ray tube. The gain of the stage is approximately 12.5. A switch, S3, is provided for direct connection of a signal to one of the vertical deflection plates.

f. CALIBRATION GENERATOR.

Figure 2—10 shows the calibration generator. It consists of V7, a JAN 12AU7 duo-triode. It is a symmetrical multivibrator, with regulated B supply for stability. It operates at a frequency of 5KC. Networks R71 and C30, and R74 and C33 are shaping networks in the grid circuits of the duo-triode to give improved shaping of the output wave form. One output goes

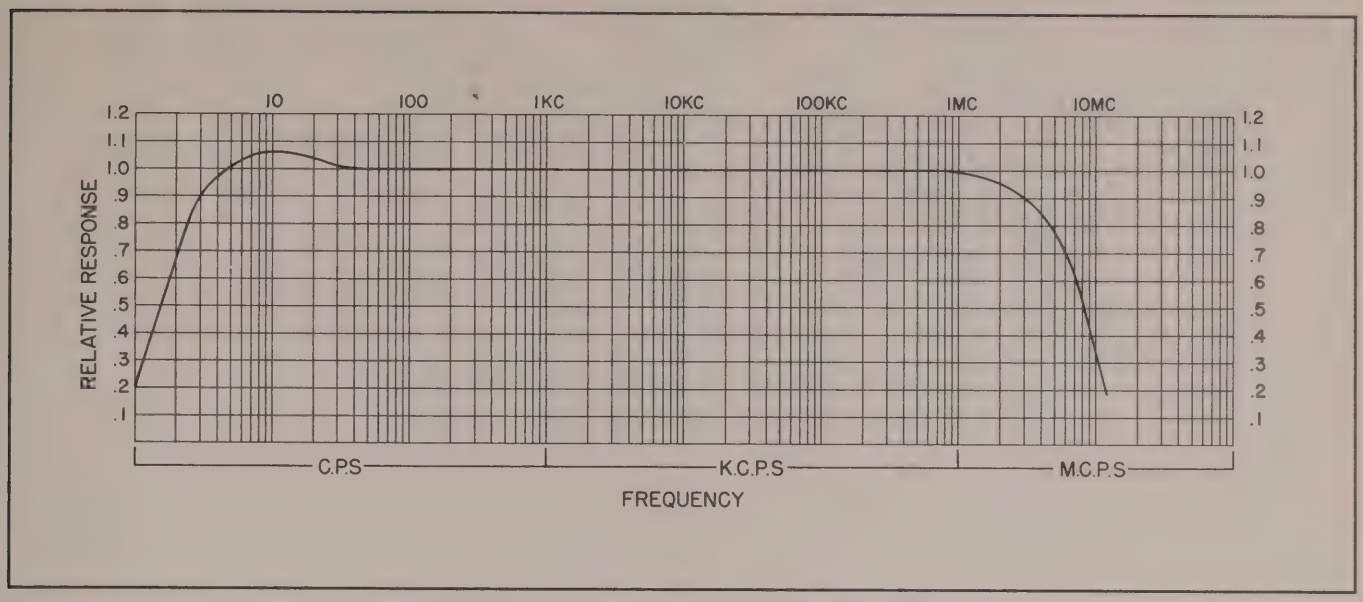


Figure 2—5. Typical Frequency Response

through the CAL VOLTS potentiometer, R79, to the CALibration switch, S2, in the vertical pre-amplifier circuit. Attached to the CAL VOLTS potentiometer shaft is an accurately indexed dial having a range of .1 to 1 volt peak to peak. There are two adjusting potentiometers; R78 to adjust the 1 volt end of R79, and R80 to adjust the .1 volt end of R79. The output has essentially square wave characteristics. A separate output is connected to TEST VOLTS OUTPUT, J3, for external use.

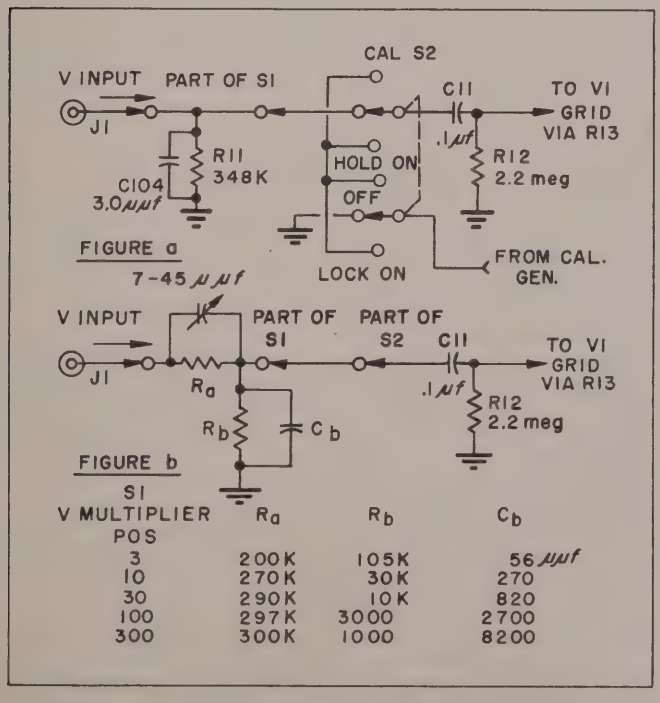


Figure 2—6.
V Multiplier—Simplified Schematic

4. HORIZONTAL CHANNEL.

a. GENERAL.

The function of the horizontal channel is to bring to the horizontal deflection plates a signal of the correct amplitude and shape for the desired horizontal sweep. The input, internally, to the horizontal amplifier, is from the linear time base channel; either normal or delayed expanded sweep, or from an external source through J10, H INPUT. It consists of a HORIZONTAL AMPLIFIER, AND HORIZONTAL OUTPUT AMPLIFIER. Figure 2—11 shows the horizontal channel.

b. HORIZONTAL AMPLIFIER.

The horizontal amplifier (See Fig. 2—11) consists of V28B, 1/2 JAN 12AU7 duo-triode, with the gain control in the plate circuit. Positive going input signal becomes negative going in the plate circuit. This negative going signal is clamped by the action of V28A, 1/2 JAN 12AU7 duo-triode connected as a diode, with resistor R195 shunted across it. The impedance of this circuit is 10 megohms for negative values of the signals, but positive values cause V28A to conduct and become a low value of impedance. Thus, the negative going signals are clamped at ground potential and applied to the grid of the following stage.

This amplifier stage is biased by resistor R194 in the cathode circuit and high frequency peaking is provided by capacitor C98 in parallel with it.

When a signal is applied to the horizontal amplifier from an external source (via J10) or from normal internal sweep, the signal is attenuated by a network consisting of R189 paralleled by variable capacitor, C96, and R190 in parallel with C97.

When the applied signal is from the expanded delay sweep generator the attenuator network components are switched by contacts of the SWEEP DELAY switch,

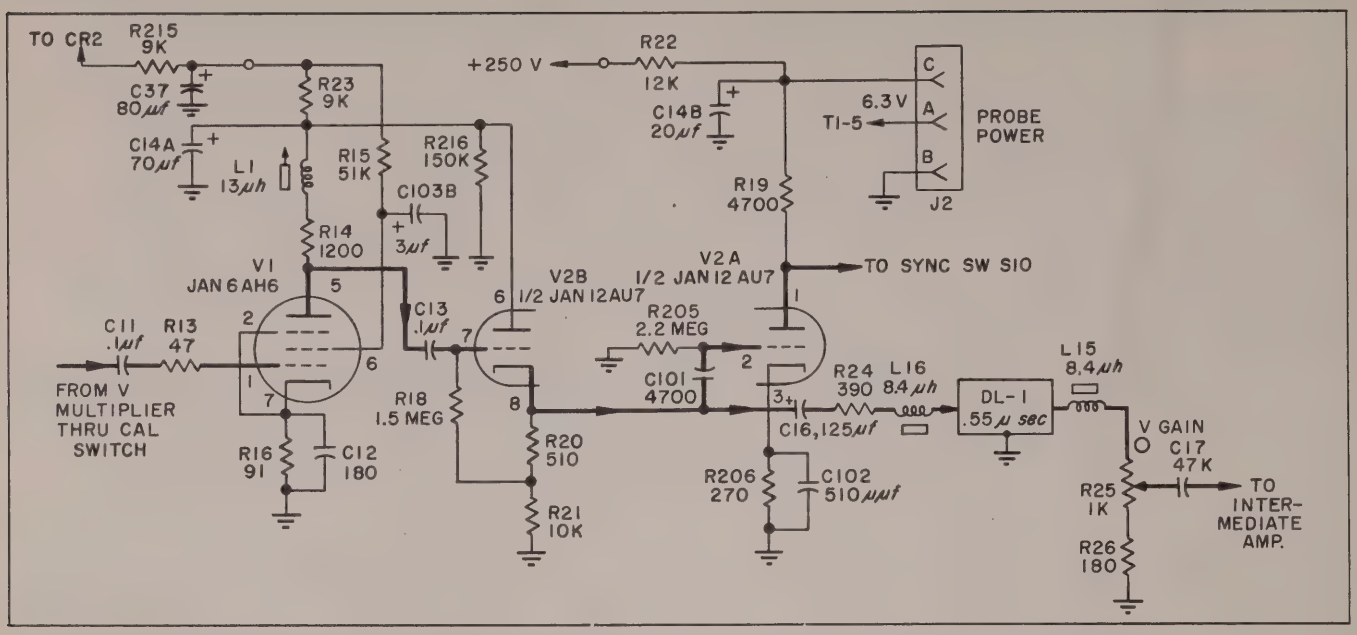


Figure 2—7. Vertical Pre-Amplifier, Delay Circuit and Internal Sync Take-off—Simplified Schematic

S15, to form an input resistor of 6.2 megohms for the grid of V28B.

Capacitor C60C with resistors R191 and R192 form the plate supply decoupling network. The gain of this stage is 8 from grid to plate but effectively 1.15 input to output due to the input attenuator.

c. HORIZONTAL OUTPUT AMPLIFIER.

This stage consists of V29, a JAN 12AU7 duo-triode, connected as a grid driven and cathode driven push-pull output amplifier stage. With no signal input, V29A normally conducts more heavily than V29B, since its grid is less negative than the grid of V29B. Negative signal at the grid of V29A produces negative signal on the cathode. Since both cathodes are tied together, the signal applied to V29B cathode has the opposite effect as the signal at the grid of V29A. This results in push-pull output at the plates. The grid of V29B is AC grounded through capacitor C100. R196

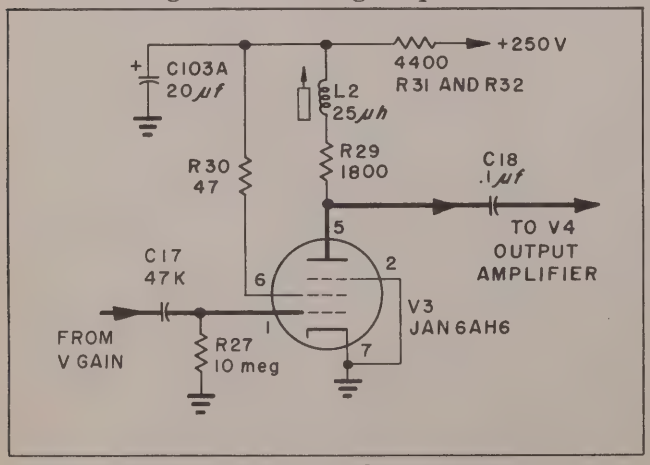


Figure 2—8. Vertical Intermediate Amplifier—Simplified Schematic

the Horizontal POSition control varies the bias of V29B and thereby the operating points of V29A/B. This causes the voltages at the plates to change and repositions the spot or trace on the display tube. V28A maintains that position regardless of duty cycle by clamping action at the grid of V29A. When the normal sweep length is two and one-half inches and then expanded sweep is applied, the amplitude is intentionally of such magnitude as to cause grid "cut-off" and plate current saturation at the amplifier tubes. At the same time one set of contacts on the SWEEP DELAY switch, S15, open to allow resistor, R219, to change the bias of V29B so that the most linear portion of the expanded sweep is on the display tube screen. The gain of the output amplifier is approximately 13.

5. LINEAR TIME BASE CHANNEL.

a. The linear time base channel consists of an enabling gate generator, a linear sweep generator and a sweep delay generator. The function of this channel is to provide the proper signal to create linear horizontal sweep, and if desired, to take a portion of that sweep, delay and expand it for closer observation and measurement of the incoming signal. It also provides a gate for keying the marker generator and a signal for the intensity gate amplifier.

b. ENABLING GATE GENERATOR.

Figure 2—12 shows the enabling gate generator. The generator is a multivibrator whose repetition rate is easily controlled. It consists of V16A, 1/2 JAN 12AT7WA duo-triode, and V17, a JAN 12AU7 duo-triode. V16A is cut off due to its grid being returned to —200V, while V17B is conducting heavily since its grid is essentially at "zero" bias. The plate of V16A is directly coupled to the grid of V17A, which is connected as a cathode follower. Thus the voltage on the

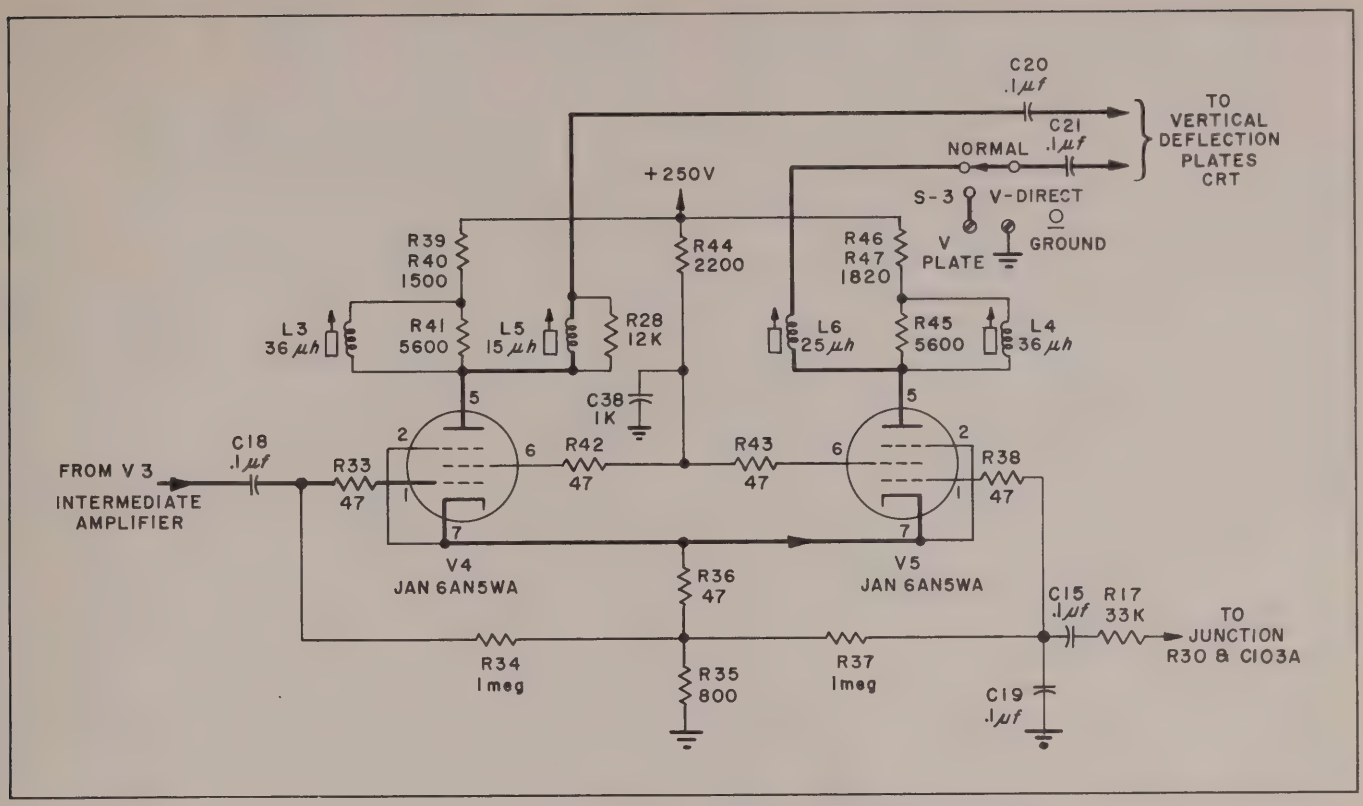


Figure 2–9. Vertical Output Amplifier—Simplified Schematic

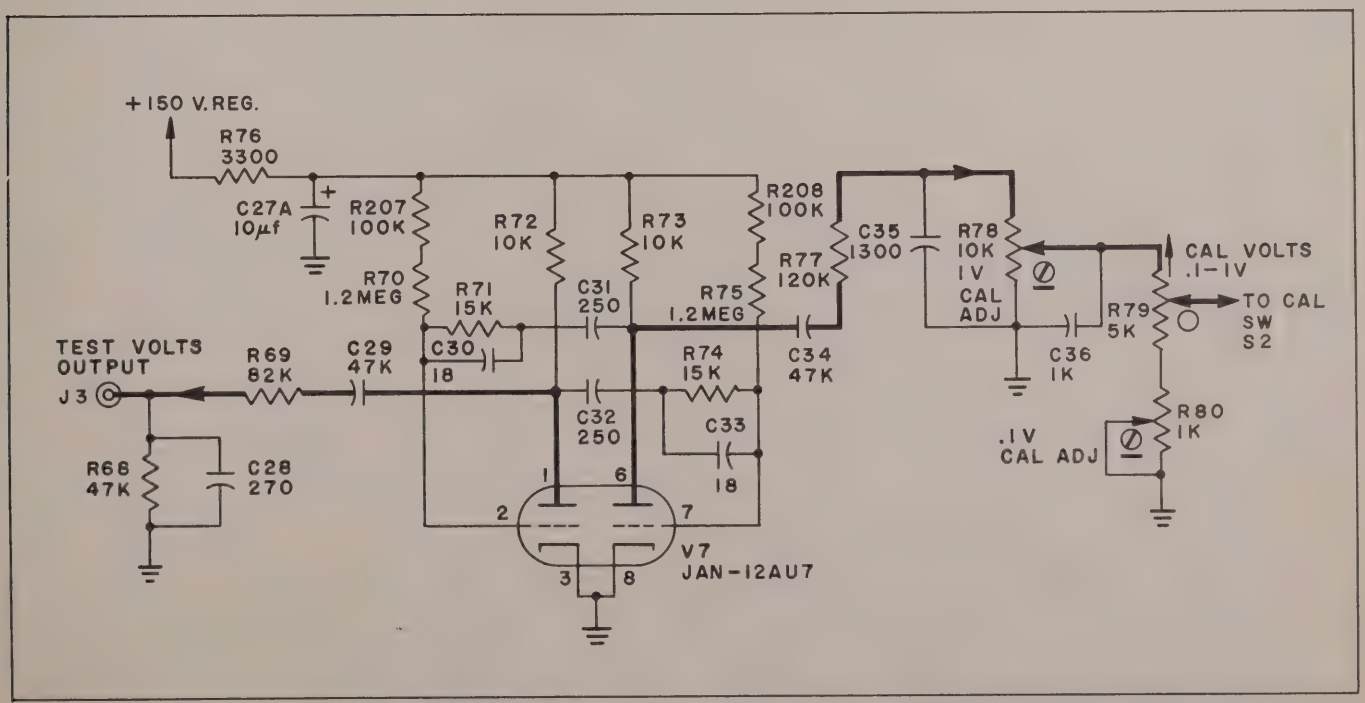


Figure 2–10. Calibration Generator—Schematic

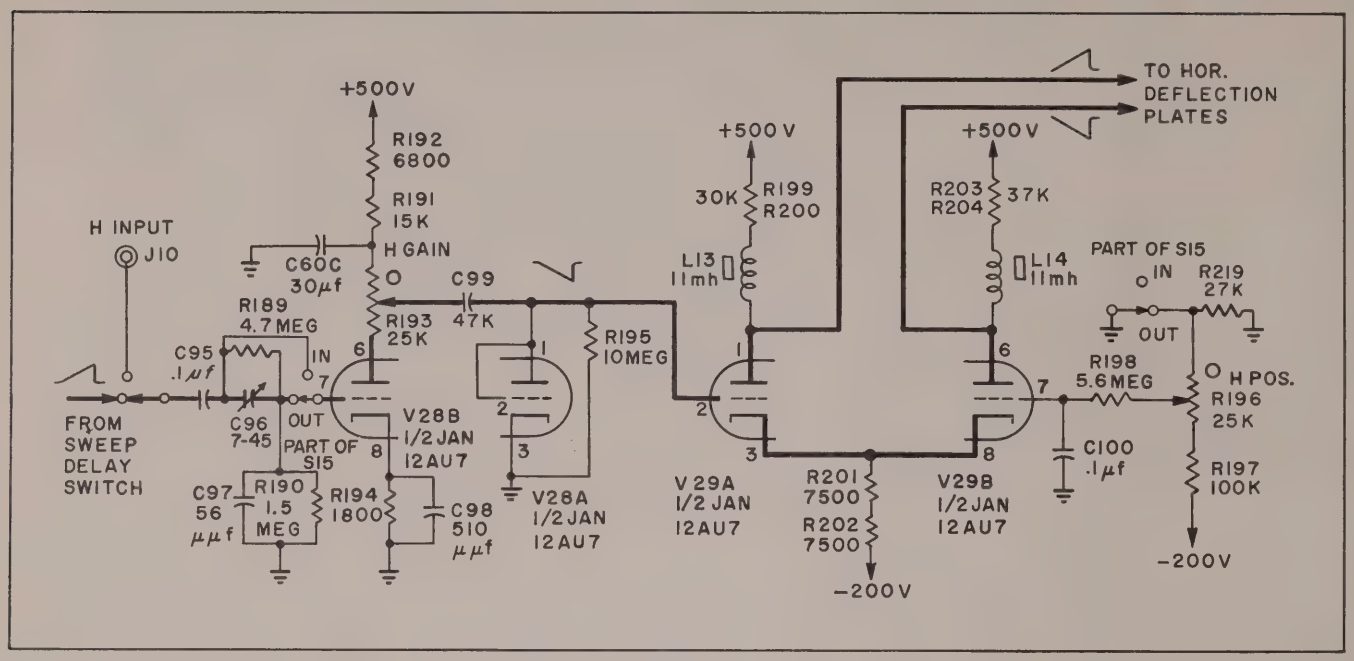
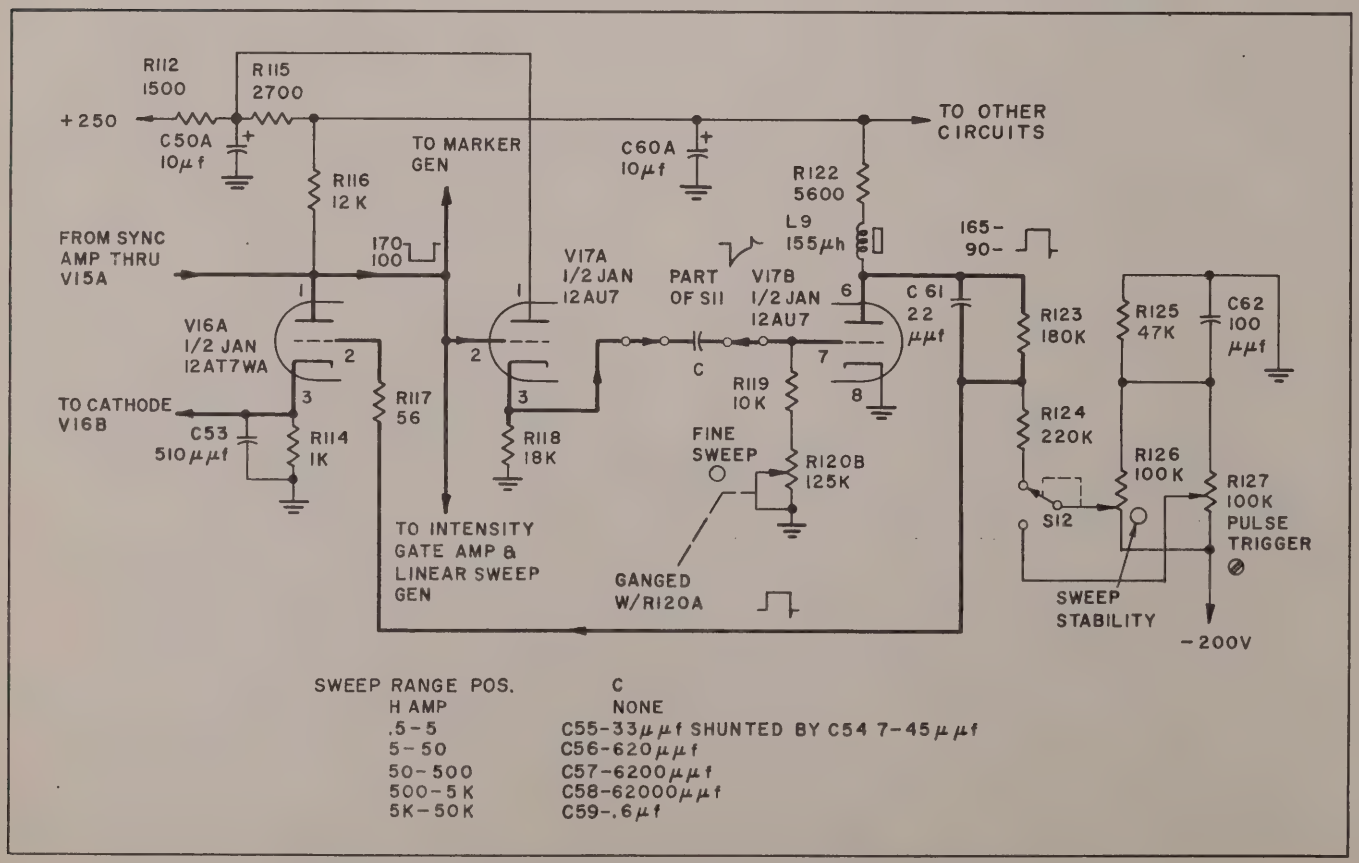


Figure 2—11. Horizontal Channel—Simplified Schematic



SWEEP RANGE POS.	C
H AMP	NONE
.5-5	C55-33μμf SHUNTED BY C54 7-45μμf
5-50	C56-620μμf
50-500	C57-6200μμf
500-5K	C58-62000μμf
5K-50K	C59-.6μf

Figure 2—12. Enabling Gate Generator—Simplified Schematic

cathode of V17A is the same phase as the voltage on the plate of V16A. V17A is used as a cathode follower because its high input impedance does not load V16A, and its low output impedance permits very rapid charge and discharge of the time-constant network in the grid circuit of V17B. By setting of the SWEEP STABILITY control, R126, the generator can be operated either periodically or triggered. When the generator is operated as triggered, negative signal from the synchronization channel causes the plate of V16A to go negative. As the cathode of V17A goes negative, the grid of V17B goes negative and the plate of V17B goes positive. This positive signal is coupled back to the grid of V16A, and this regenerative action continues until the voltage on the plate of V16A drops to a definite level as determined by the tube characteristics and associated circuits. This large negative voltage drives the grid of V17B well below "cut off". Capacitor C then charges exponentially through a comparatively large resistor (consisting of FINE SWEEP potentiometer R120B and resistor R119) from the voltage across R118 until the voltage on the grid of V17B rises out of "cut off". The action then reverses itself and the grid of V17B swings positive. This causes the plate of V17B to go negative, and now capacitor C is rapidly discharged by the low resistance of the diode action between the positive grid of V17B and its cathode in series with the low impedance cathode circuit of V17A. The generator now returns to a quiescent condition until the next pulse from the synchronization channel causes it to repeat the cycle. The value of capacitor C (selected by SWEEP RANGE Switch, S11), together with potentiometer R120B and resistor R119, determine the "on" time of the enabling gate generator. The gate is taken from the plate of V16A to the linear sweep generator, marker generator and intensity gate amplifier. When the SWEEP STABILITY control is adjusted for less negative voltage on the grid of V16A, the generator operates periodically and the sync signal is used to synchronize the enabling gate generator rather than trigger it. When the SWEEP STABILITY control is rotated fully counter clockwise a snap switch S12 is actuated, replacing potentiometer R126 by potentiometer R127 in the circuit. This control, R127, is a screw-driver control inside the unit, preadjusted for trigger operation with standard pulses.

c. LINEAR SWEEP GENERATOR.

(1) Figure 2—13 shows the linear sweep generator. It consists of V25B, 1/2 JAN 5726 duo-diode and V26, a JAN 12AU7 duo-triode. It produces a voltage which increases linearly with time, normally called a "sawtooth" voltage.

(2) The attenuated negative gate from the enabling gate generator is applied to the grid of V26B, allowing capacitors C86 and C to charge exponentially through resistors R175 and potentiometer R120A for the duration of the gate. The most negative portion of the negative gate is clamped at —6V by the clamping action of V25B. During the interval between gates, V26B conducts and discharges capacitors C86 and C. The value of C is selected by a set of contacts on SWEEP RANGE Switch, S11. The resultant wave form is applied to the grid of V26A, which is connected as a cathode follower and "Bootstrap". The sweep voltage at the cathode of V26A is the same as that at the grid, therefore this output voltage is positive going. This voltage is fed back to the charging voltage through C85, creating the "Bootstrap" effect which is used for linearizing the trace. The output is fed to the SWEEP DELAY switch S15, to allow the signal to be switched either directly to the horizontal amplifier or through the sweep delay generator. A portion of the cathode voltage is also fed to the SWEEP OUTPUT jack, J9. FINE SWEEP potentiometer R120A in this circuit is ganged with potentiometer R120B in the enabling gate generator to maintain a constant amplitude of signal regardless of FINE SWEEP positioning.

d. SWEEP DELAY GENERATOR.

The sweep delay generator is shown in figure 2—14. It consists of V27, a JAN 12AT7WA duo-triode, and V25A, 1/2 JAN 5726 duo-diode. V25A is always in the circuit to clamp the negative excursion of the sweep voltage to ground potential either in direct or delayed presentation to the horizontal channel. The delay generator, V27, is operated with one section being grid driven and the other section cathode driven. In sweep delay operation, the signal from the linear sweep generator is applied to the grid of V27B. The cathode resistor R184 is returned to —200V, and the cathode DC voltage changes with this grid, maintaining the same bias and therefore the same gain for V27A. However, as the common cathode DC voltage is raised the operating point of V27B is greatly affected because its grid is returned to ground through R181. This results in a selective action at the cathode allowing a portion of the sawtooth voltage at V27B to be coupled to, and amplified by V27A. The selected portion is amplified and then coupled from the plate of V27A to the horizontal amplifier. The plate load for V27A consists of resistors R218 and R183. The combination of resistors R218 and R183 paralleled by capacitor C92, is an equalizing network to maintain equal outputs for both the high and low frequency sweeps. The combination of coil L17 critically damped by resistor R182 provides additional high frequency peaking.

This stage fulfills the requirement of providing variable delay and expansion of a portion of the normal sweep.

6. SYNCHRONIZATION CHANNEL.

Figure 2—15 shows the circuit of the synchronization channel which consists of V14, a JAN 12AT7WA duo-triode, V15, a JAN 5726 duo-diode and V16B, 1/2 12AT7WA duo-triode. It presents a synchronizing or triggering signal of the proper amplitude and polarity (negative) needed for rapid triggering of the gate generator section of the linear time base channel. A

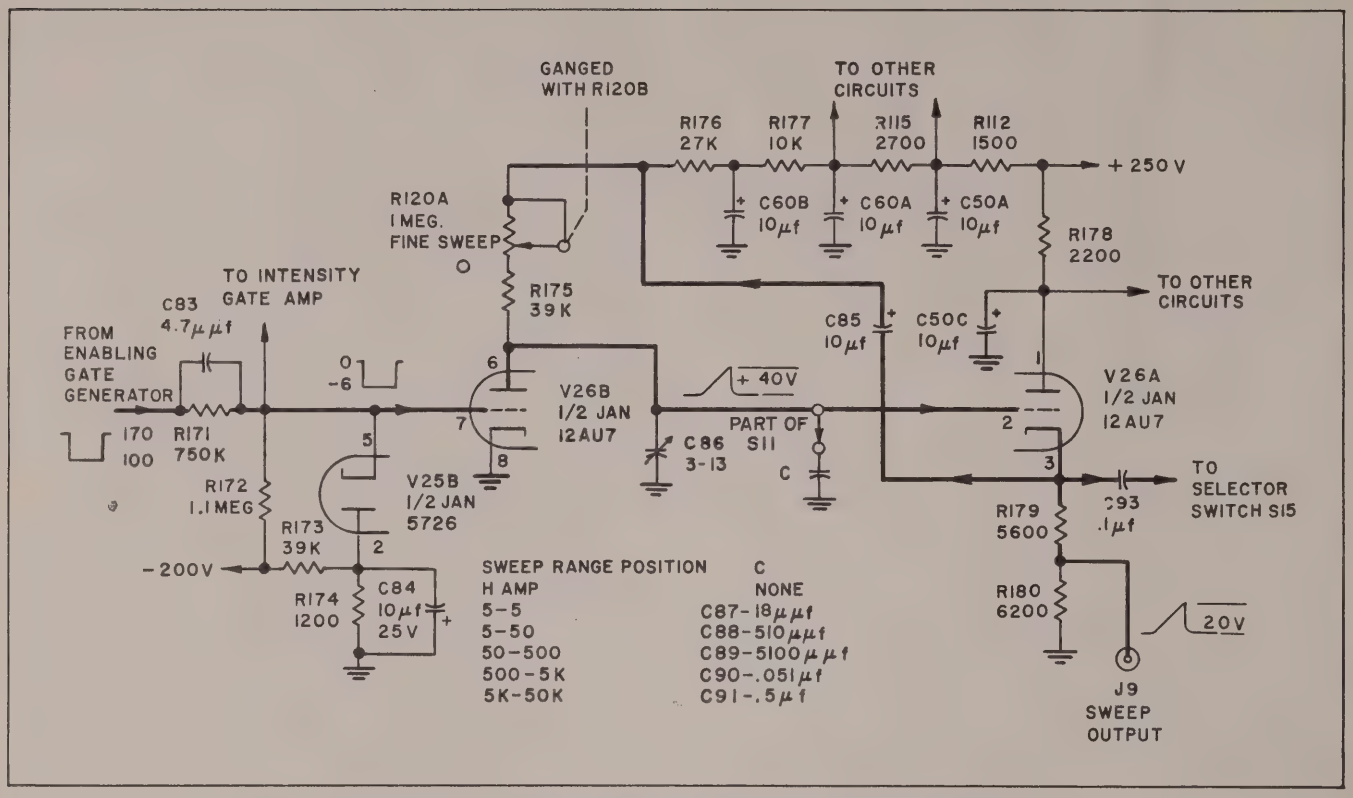


Figure 2—13. Linear Sweep Generator—Simplified Schematic

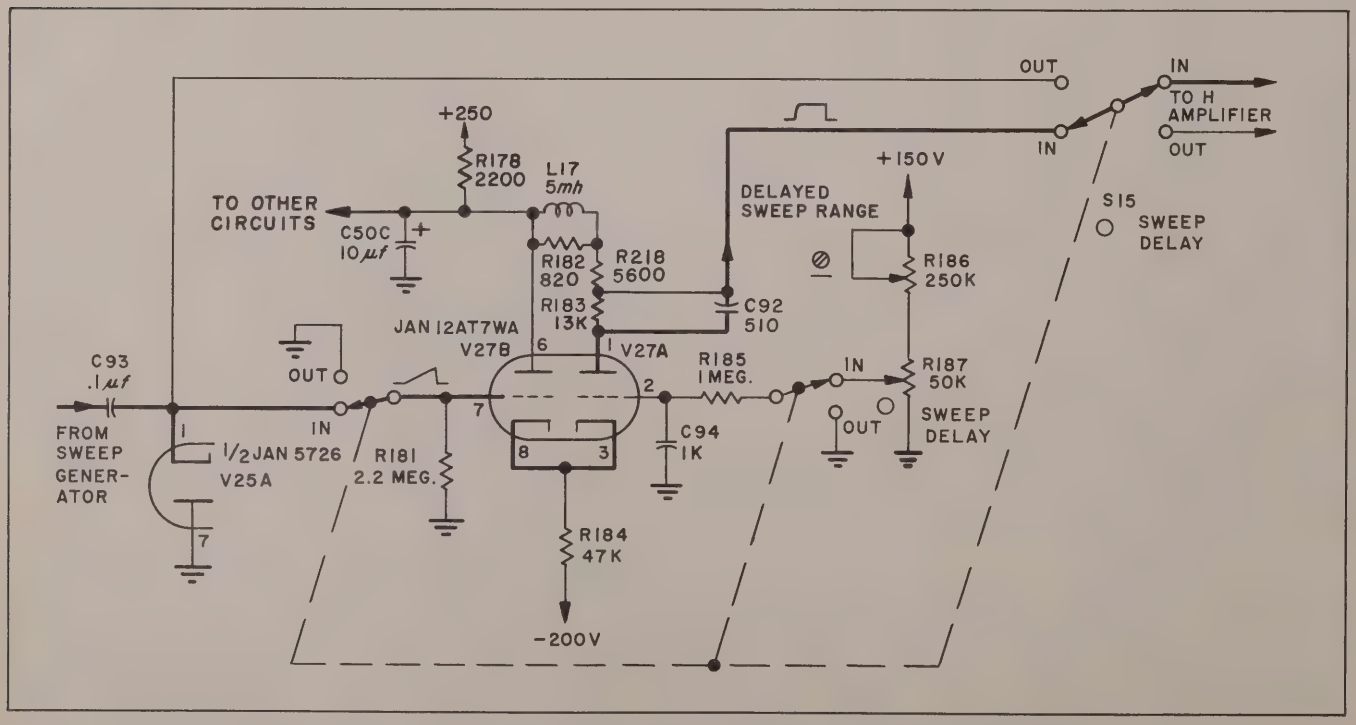


Figure 2—14. Expanded Sweep Delay Generator—Simplified Schematic

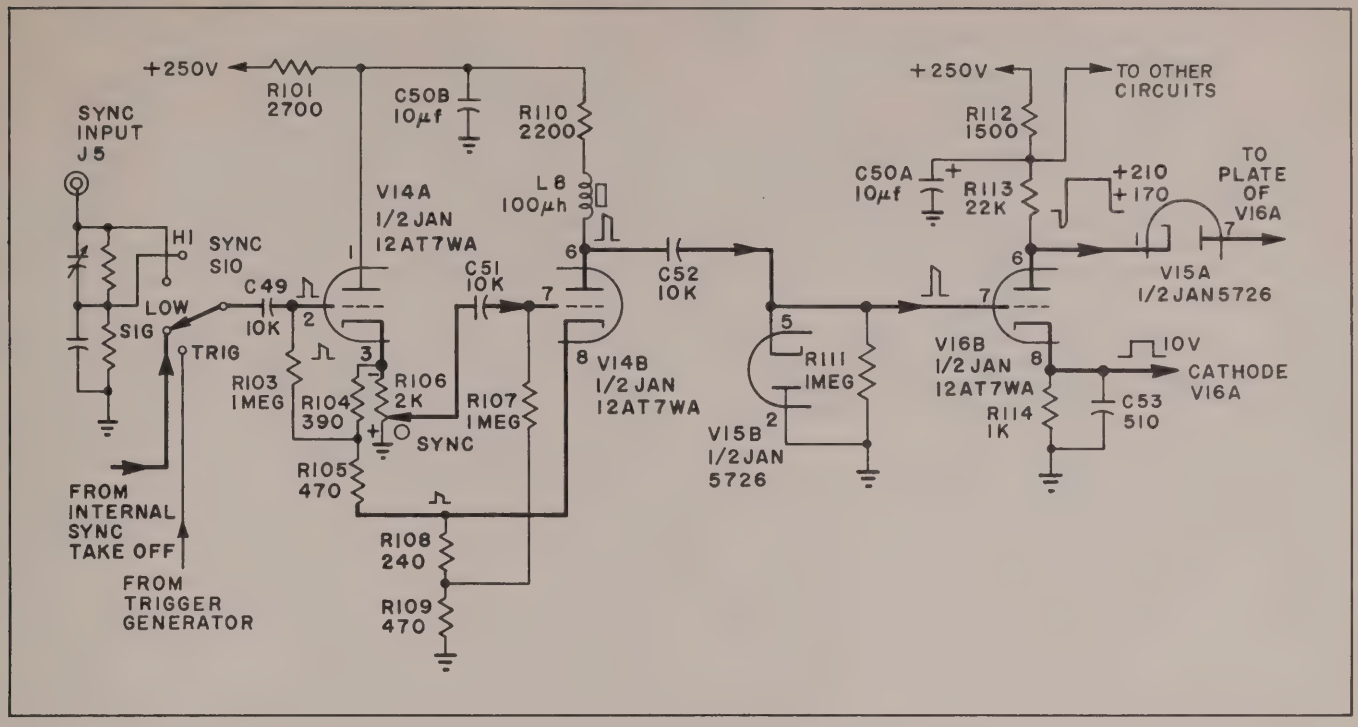


Figure 2–15. Synchronization Channel—Simplified Schematic

switch, S10, is used for selecting the mode of synchronized operation and includes a 30 to 1 attenuator to allow external sync signals of high amplitude to be used.

a. SYNC INTERMEDIATE AMPLIFIER.

The sync intermediate amplifier consists of V14A connected as a cathode follower and V14B which functions as either a grid or cathode driven amplifier, depending on positioning of the SYNC control, thereby producing either 0° or 180° phase shift and variable amplitude of the SYNC signal. The cathode load resistor for V14A consists of series resistors R104, R105, R108 and R109 paralleled by SYNC control R106. When the slider of SYNC control potentiometer R106 is at the cathode end, V14B is grid driven by signal across R104 and R105. When the slider is at the ground end, V14B is cathode driven by signal across R108 and R109. When the slider is half way or at electrical zero, the signals at the grid and cathode are equal and of opposite polarities to affect changes of plate current and, therefore, no amplification results. At intermediate positions of the slider of R106, some intermediate value of amplification results on the plate of V14B and the signal is negative or positive dependent upon whether the grid or cathode is being driven harder. When a negative-going pulse is applied to the grid of V14A, a negative pulse will appear across the cathode load resistors. With the slider towards the cathode end of R106, this signal will drive the grid of V14B negative and cause an amplified positive pulse to appear at its plate. When a positive-going pulse is applied to the grid of V14A, a positive pulse appears across the cathode load resistors. Now, if the slider of R106 is moved towards the ground end, the signal will drive the cathode of V14B positive and again cause an amplified positive pulse to appear at the plate. These positive signals are of the proper polarity to once again be amplified and inverted to result in a negative pulse necessary for triggering the gate generator.

b. SYNC AMPLIFIER.

The sync amplifier and coupling circuits include V15, a JAN 5726 duo-diode, and V16B, 1/2 JAN 12AT7WA duo-triode. The positive pulse or signal from the plate of V14B is capacity coupled via C52 to the grid of V16B. The DC level of this signal is always clamped to ground potential by diode V15B. The positive pulse appearing at the grid of V16B is amplified and inverted at the plate. This amplified negative pulse is coupled to the plate of the gate generator via diode V15A. This negative pulse is of the proper polarity for triggering the gate generator in synchronization with the start of the pulse or signal being observed. It is to be noted that when a sine wave or other bi-directional wave is coupled to the sync intermediate amplifier and the slider of R106 is towards the ground end (+ marking on front panel), no phase reversal takes place from the input of V14A to the input of V16B. The first inversion of the signal takes place at the plate of V16B and the original rise in the wave form is now negative which is the proper polarity for triggering. In the event the control is moved towards the cathode end (— marking on front panel), then phase reversal takes place in the plate of V14B and again at the plate of V16B. The negative portion of the wave is then 180° behind the apparent

start. This has the effect of reversing the phase of the signal observed through the vertical amplifier.

7. INTENSITY CHANNEL.

a. The intensity channel consists of two basic sections—the intensity gate amplifier, and the marker generator and amplifier. The intensity gate amplifier functions to apply positive pulses to the grid of the cathode ray tube to intensify the electron beam so that it is visible only during trace time of the linear sweep output. The marker generator and amplifier generate and apply narrow negative pulses to the display tube cathode to further intensify the beam and appear as intensified marks on the trace for use of time measurements.

b. INTENSITY GATE AMPLIFIER.

Figure 2—16 shows the intensity gate amplifier. It consists of V24, a JAN 6135 triode. An attenuated portion of the negative gate from the enabling gate generator is DC coupled to the grid of V24. The duration of this gate is, therefore, the same as the duration of the SWEEP and varies with SWEEP RANGE and FINE SWEEP settings. This negative gate, which is essentially a negative square wave, is further squared off by clipping at the zero level by diode action from cathode to grid of V24 and is clamped at —6V by diode V25B. The square wave is then amplified and inverted and the resultant positive square wave is coupled to the grid of the cathode ray tube via capacitor C22. R170 is the plate load resistor while R169 in conjunction with C82 provides low frequency compensation.

c. MARKER GENERATOR AND AMPLIFIER.

Figure 2—17 shows the circuits of the marker generator and amplifier. The tubes used are V18 and V21, each a JAN 12AT7WA duo-triode, V20, a JAN 6135 triode and V22, a JAN 6AH6 pentode. V21 is a cathode coupled multivibrator whose time constants Ca and Ra are selected by MARKER μS switch S13. The operating conditions for each half of the tube are selected

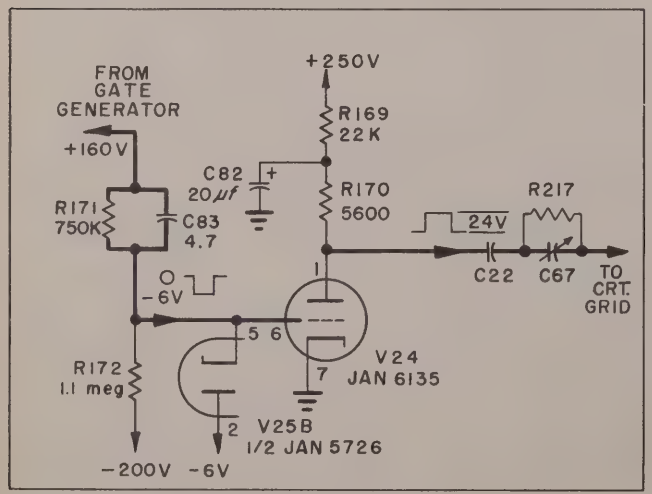


Figure 2—16. Intensity Gate Amplifier—Simplified Schematic

to make the circuit a free running asymmetrical multivibrator. This produces a wave form of narrow positive-going pulses at the cathode of the tube. Tube V20 is used to partially set these conditions and also to act as a low impedance for the grid of V21A. Between gates, the multivibrator oscillations are prevented from occurring by current flowing through the following path: Cathode resistors R147 and R146; from cathode to grid of V21B, from cathode to plate of V18A and to cathode of V18B. When an attenuated portion of the negative pulse from the gate generator is applied to the grid of V18B, the cathode voltage drops to a low value. This in turn makes the plate of V18A, connected as a diode, negative with respect to its cathode thus cutting off the tube. This allows the multivibrator to start oscillating in synchronization with the gate. At the end of the gate, the grid, and therefore, the cathode of V18B, become more positive, current flows through keying diode V18A and multivibrator oscillations cease. Therefore, the markers are generated only during the sweep time. The spacing (frequency) of the markers is determined by the setting of S13 the "MARKER μS" switch which selects different values of Ca and Ra. A portion of the output of the marker generator across resistor R147 is coupled by way of Cb to the grid of V22. Capacitor Cb is also changed with the setting of S13 and in conjunction with R148 forms a differentiating network to shape the generated pulses. L11 shunted by R149 provides peaking for the high frequency components of the marker pulses. The bias on V22 is adjusted to a nonlinear operating point in order that the positive components of the marker signal will be amplified while the negative components at the grid will be suppressed. Amplified negative-going markers appear at the plate of V22 and are coupled to the cathode of the display tube via capacitor C23. The negative pulses applied to the cathode have the same effect as positive pulses applied at the grid and, therefore, produce intensified dots or markers on the trace. Contacts are provided on switch S13 to allow external markers or signals to be applied at J6, BEAM MOD INPUT jack, and amplified by V22. The power supplied to the marker generator and marker generator control tubes is regulated to prevent frequency changes with line supply variations. Potentiometer R130 is provided for adjusting the amplitude of the keying gate. Potentiometer R135 is provided for adjusting the DC level at the grid of V20, thereby controlling the grid of V21A. Adjustable capacitors and resistors are provided for precise adjustment of each marker frequency. R137 in conjunction with C71A form a decoupling filter to prevent marker pulses from entering other circuits.

8. TRIGGER GENERATOR.

a. Figure 2—18 shows the trigger generator circuit, which consists of V23 JAN 12AU7, a duo-triode with both sections connected in parallel, pulse transformer T2, and associated circuits. Its function is to provide pulses of different repetition rates for triggering the

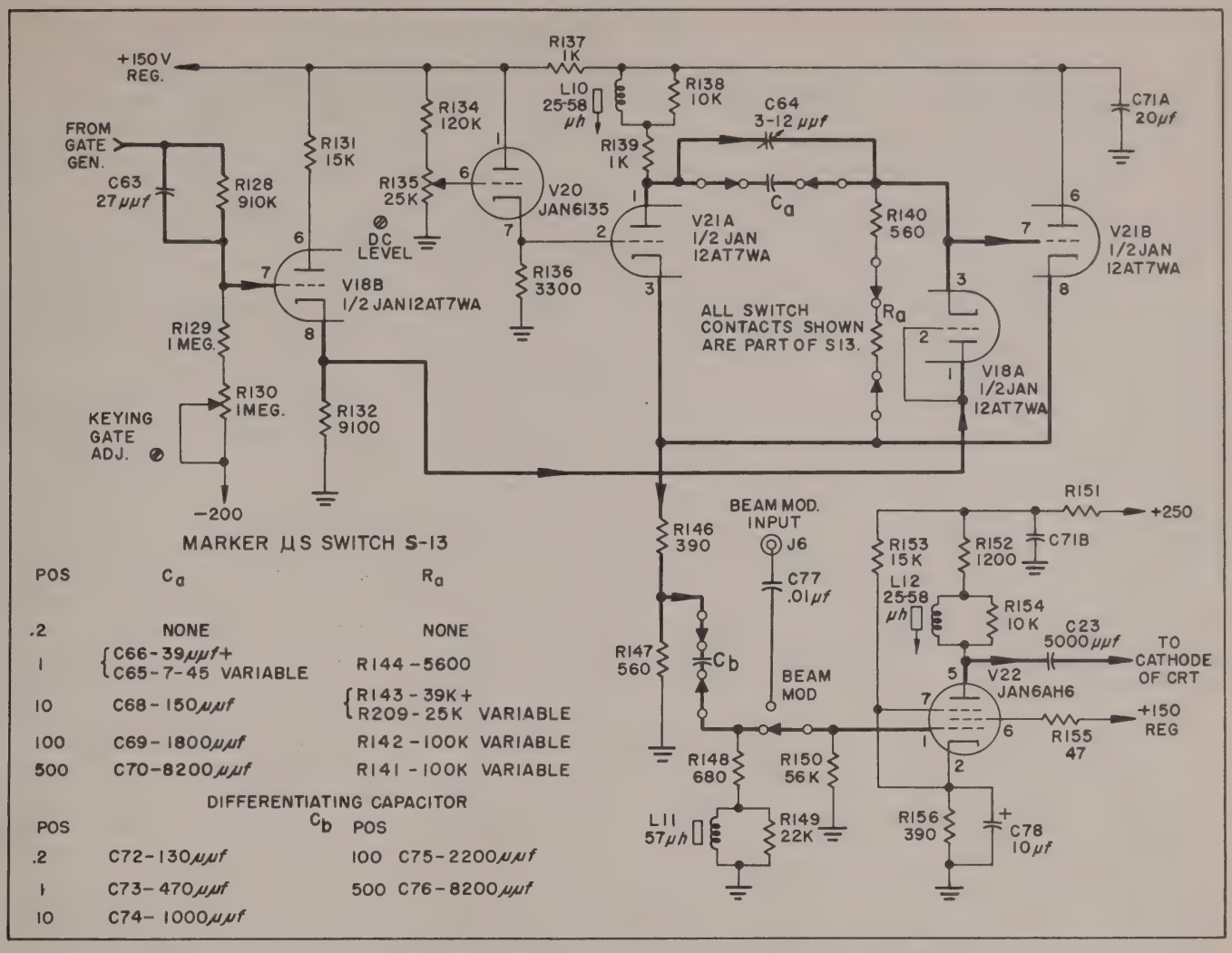


Figure 2–17. Marker Generator and Amplifier—Simplified Schematic

linear time base channel through the synchronization channel, and also to provide pulses for external use to control the equipment whose output is being studied. Both positive and negative polarity pulses are available at output jacks J7, —TRIGGER OUTPUT, and J8, +TRIGGER OUTPUT.

b. The trigger generator is a free running blocking tube oscillator. The windings of the pulse transformer are so connected that any voltage variations on the plates of V23 are coupled back to the grids in a regenerative manner. Thus, when the plate current starts to increase, the resultant voltage pulse is coupled back to the grid as a positive pulse causing the tube to conduct more heavily, and this regenerative action continues until the tube reaches saturation. At this point, the grid is more positive than the cathode, and together with the cathode functions as a diode to discharge C81 through R210 and the grid windings of T2. The time interval, from maximum charge on C81 until the grid approaches "cut-off", determines the pulse duration of the generator. As the grid approaches "cut-off", the plate current starts to decrease, and the resultant pulse is coupled back to the grid causing the grid to swing more negative, until it is driven well below "cut-off". The large negative charge on C81 now discharges through resistors R_a, R166, R160 and R159. Varying the resistance (R_a) in this circuit will vary this discharge time, and thus controls the pulse repetition rate of the generator. The TRIGGER PPS switch, S14, contains five values of R_a, allowing the selection of repetition rates of 50, 300, 800, 2000 and 5000 pulses per second. R168, the trigger rate adjust control, is used to vary the DC bias on the grid of the oscillator. This has the same effect as changing all of the time constants, and therefore provides means of adjusting the repetition rates for differences in tube characteristics. Negative pulses across R158 are coupled via C79 to the —TRIGGER OUTPUT connector J7, and positive pulses from the cathode are DC coupled to the TRIGGER OUTPUT connector J8. The positive pulses developed across R160 are coupled to the SYNC selector switch (S10). Resistors R157, R212 and capacitors C80 and C71C form a brute force filter to prevent any pulses from entering the +250 volt supply.

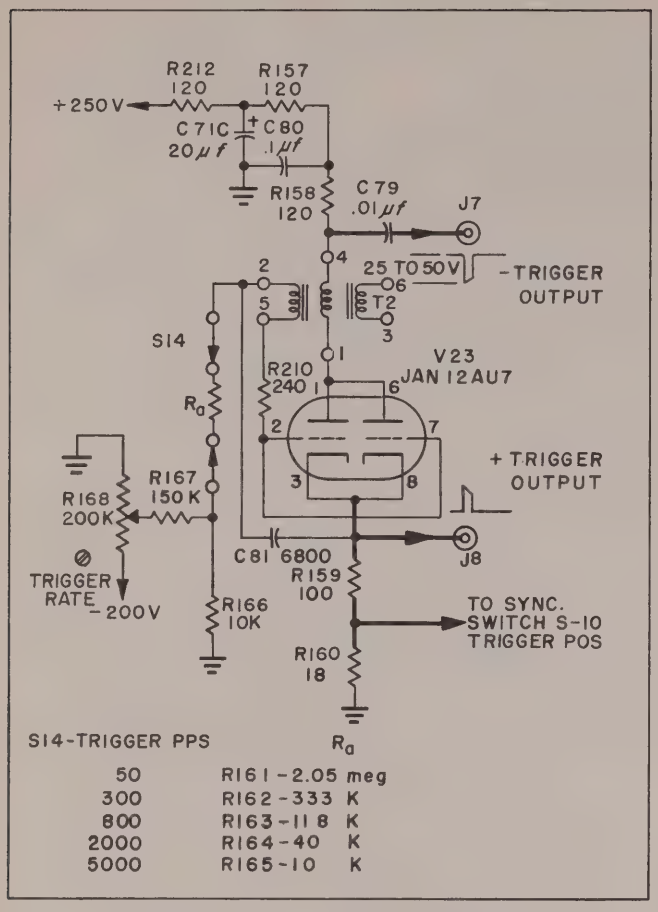


Figure 2—18. Trigger Generator—Simplified Schematic

9. POWER SUPPLY CHANNEL.

Figure 2—19 shows the power supply channel. There are seven sources of supply voltages, in addition to tube heater voltages and auxiliary circuits.

a. A 12 volt DC supply is used for the motor of the blower assembly. This consists of a selenium full wave bridge rectifier CR1, a protective resistor R211 and a ripple filter C39. A bi-metallic thermal switch S4 automatically closes the circuit and starts the blower when the ambient temperature inside the oscilloscope reaches 50°C (112°F) and opens when the temperature drops below 30°C (86°F).

b. A regulated +150V supply is used to stabilize critical circuits. It is obtained by dropping the voltage from the main +250V supply and taking the output across regulator tube V19, a JAN OA2WA.

c. The main supply is +250 volts DC. This consists of four 6203 duo-diodes connected so that 4 diodes are in parallel across each half of the center tapped transformer winding. This forms a full wave rectifier circuit having a low ripple level. The supply is filtered by a low pass filter consisting of capacitors C26C and C27C in parallel, reactor L7 and capacitors C26B and C27B also in parallel.

d. An intermediate supply of +500V DC is used. This is obtained by adding two +250V supplies in series. The 270 volts A.C. across transformer winding 11-12 is rectified by CR-2. The resulting unidirectional voltage is then filtered by a low pass filter consisting of capacitor C40B, parallel resistors R181 and R182 and capacitor C40A. The negative side of this +250V supply is connected to the positive side of the main +250V supply resulting in a total of +500 Volts.

e. A —200 volt supply is used in the oscilloscope. It consists of a half wave selenium rectifier CR3, and a brute force RC filter using resistors R91 and R92 and capacitors C41, C42 and C43.

f. A high voltage supply of +1900 Volts is used for the intensifier anode of the cathode ray tube. Half wave rectification is obtained through V12, a 1V2 high voltage diode. Resistor R93 and capacitor C44 provide filtering.

g. A negative high voltage supply of —1200 volts is used to supply other operating voltages for the cathode ray tube. Half way rectification is obtained using V13, a 1V2 high voltage diode and RC filtering is accomplished with resistor R63 and capacitor C46.

h. Two interlocks are provided for equipment and personnel safety. S6, figure 4—1 and 7—21 is a normally closed spring-return switch that is actuated by the rear ventilation door to open the contacts when the door is closed. Thus, it prevents line voltage from being applied unless the ventilation door is open. S7, figure 7—21 and 7—28 is a safety interlock, normally open contact switch that is held in the closed position as shown, by the case of the oscilloscope. It prevents line voltage from being applied in order that no hazardous voltages will exist when the oscilloscope OS-51/USM-24C is removed from its combination case.

i. S8, figure 4—1 and 7—19 is a three position screwdriver slotted switch. It is provided so that the oscilloscope can be used under normal, high or low line voltage conditions. It is on the front panel under a transparent cover, which is interlocked with the power connector plug to prevent switching while the power is ON.

j. S5, figure 4—1 is a three position toggle switch. In center position, power is "OFF"; switched to the right side, power is "ON" for the oscilloscope; and to the left side, energizes a heater HR1, for use when the oscilloscope is not being used and humidity conditions are high.

k. Two fuses F1 and F2 are used, one on each side of the AC line, each with a rating of 4 amperes.

l. A radio frequency interference filter FL1, figure 7—29 is included to prevent conducted or radiated radio frequencies from leaving the oscilloscope and interfering with the operation of other equipment. The filter circuit consists of two low pass pi filters, one in each side of the power line to oscilloscope ground. This assures that one filter section is active regardless of which side of the power line is grounded.

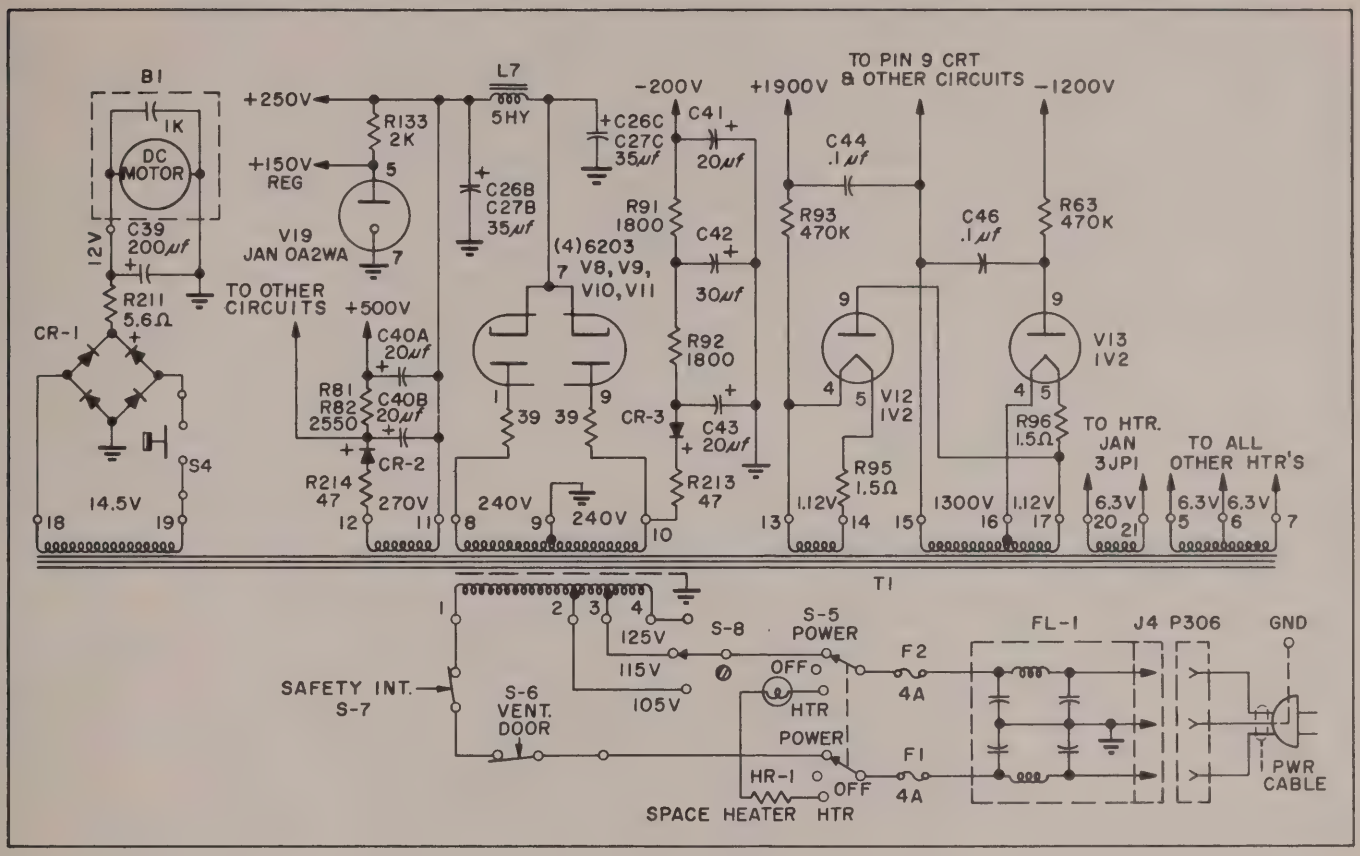


Figure 2—19. Power Supply Channel—Simplified Schematic

10. ACCESSORIES.

Figure 2—20 shows a schematic of the accessory cables. CG-883A/USM-24 is an attenuator probe, with a 10 to 1 attenuation ratio. It is frequency compensated, and has a low input capacity. CG-1277/USM-24C is also a low capacity probe but of the low-loss type and is used for low signal levels that may be affected by shunt capacity. It consists of V301, a JAN 5719 triode, connected as a grounded plate amplifier. The load resistor, R304, is in the cathode circuit. L301 is a peaking coil used to compensate for the cable capacity. Resistor R305 is included to eliminate shock hazard when installing or removing the probe connectors from the oscilloscope. The signal output is connected to the oscilloscope through P301. Power is supplied to V301 through P302, which connects to a power source (J2) on the oscilloscope.

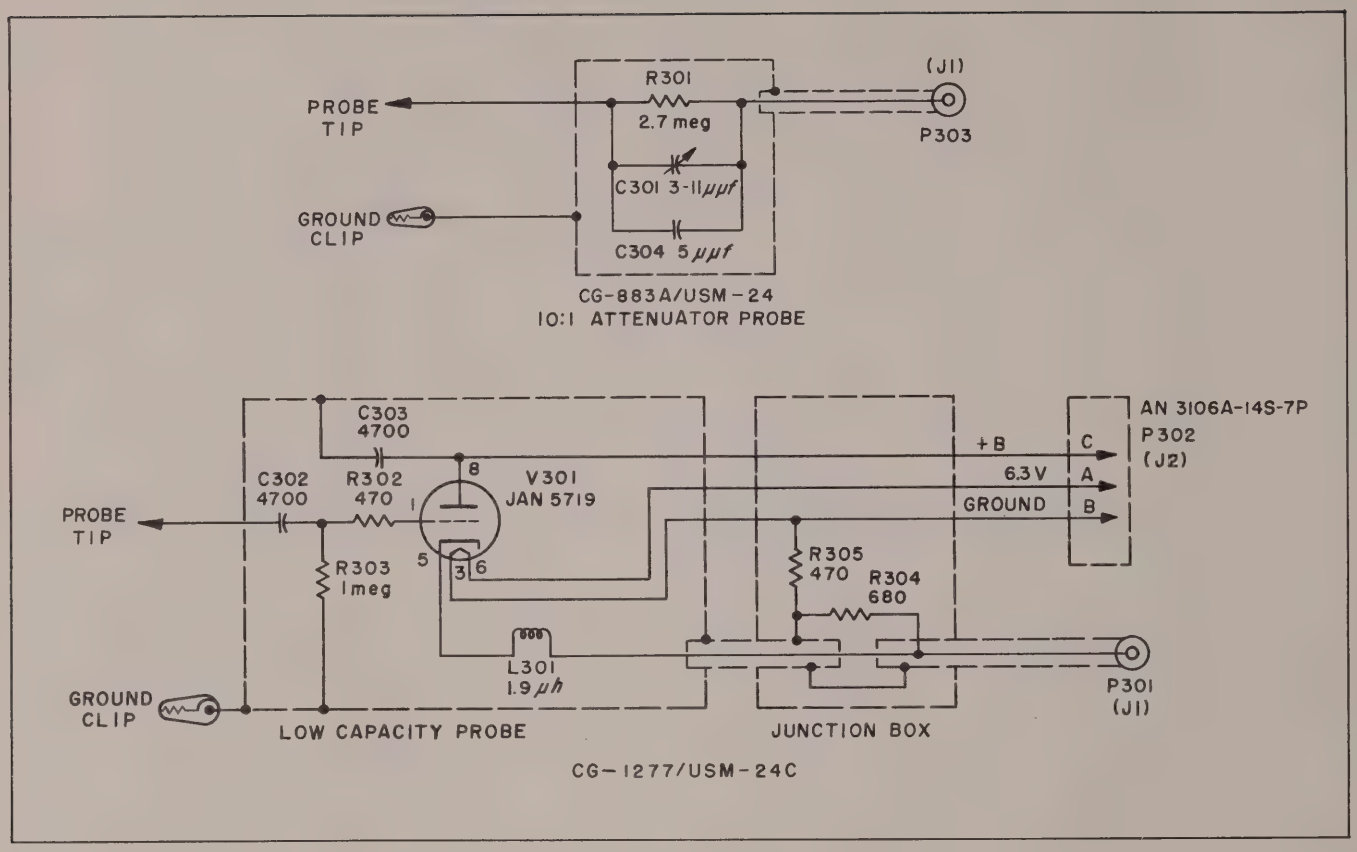


Figure 2—20. Accessories—Schematic

SECTION 3
INSTALLATION AND INITIAL ADJUSTMENT

1. UNPACKING.

Remove AN/USM-24C from the packing container. Place the oscilloscope on the table with Cover, Combination Case CW-362/USM-24C in the front. Unlock four latches to remove cover. All accessories are mounted in the cover. Two thumb fasteners on the accessory tray permit access to the compartment for instruction book and plastic schematic which is riveted to cover.

2. INITIAL ADJUSTMENT.

a. Set controls on the oscilloscope OS-51/USM-24C as indicated below:

Control	*Position*
V GAIN	½ way
SYNC	INT SIGNAL
CAL VOLTS	0.2
V POS	½ way
H POS	Fully clockwise
SWEEP DELAY	OUT
SYNC	½ way (0)
H GAIN	½ way (when sweep is obtained, adjust to 2½ inches)
SWEEP STABILITY	Fully clockwise
SCALE ILLUMINATION	Fully counter-clockwise
BEAM	Fully counter-clockwise
MARKER μS	BEAM MOD
TRIGGER PPS	OFF

b. Check the voltage of the A.C. power line to determine the appropriate setting for switch S8 (figure 4—1). This control is located on the front panel, below the power connector and has a screw driver slotted shaft. It is normally shipped from the factory, set at the 115V position for operation in the range of 110 to 120 volts. For sustained operations at lower or higher voltages, reset the switch to the appropriate position as given in table 5—1.

To reset the switch, loosen the left hand screw on the plexiglas cover and swing cover upwards. The slotted shaft is now available for adjustment.

NOTE: When the power plug is in the POWER INPUT connector the plexiglas cover is mechanically interlocked with it to prevent the switch from being actuated when power is across its terminals.

c. Insert the female end of the power cable into the POWER INPUT jack on the oscilloscope and the male end into an appropriate power line source. The power line plug is a standard parallel blade connector with a flexible ground connection extending from one side of its rubber body. The ground connection is supplied with an attached spring loaded socket and removable plug. The plug is threaded to replace the cover retaining screw on conventional wall outlet boxes. This provides a convenient, easily detached ground connector and is interchangeable with grounding connections supplied on other electrical tools and devices.

d. Open the rear ventilation door. When the power toggle switch (S5) figure 4—1, is thrown to the left, the white indicator lamp will light, indicating that the power is available to the oscilloscope and that the internal space heater is on. When the toggle switch is thrown to the right, the red indicator lamp will light, indicating that the oscilloscope power supply is on.

e. After five minutes warm-up, increase BEAM control until a spot is visible, and adjust for best spot by using FOCUS control. Use H POS for moving the spot to left and V POS to move it up or down. Turn SWEEP RANGE switch to 5K-50K position and turn CAL switch to either HOLD ON or LOCK ON. A square wave from the calibration generator will appear on the screen. Adjust SWEEP STABILITY until the square wave disappears. Adjust SYNC control until square wave reappears. Return CAL switch to OFF position.

f. Turn SYNC switch to INT TRIGGER and TRIGGER PPS to 50. Turn SWEEP STABILITY control to PULSE TRIGGER position. A horizontal line should appear. Turn MARKER μS switch to 500 and readjust BEAM for proper intensity. The 500 microsecond markers will be visible.

SAFETY NOTICE

The attention of Officers and operating personnel is directed to Chapter 67 of the Bureau of Ships manual or superseding instructions on the subject of Radio-Safety precautions to be observed.

While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high voltage supply on. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid casualties always remove power and discharge and ground circuits prior to touching them.

DON'T SERVICE OR ADJUST ALONE.

Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS.

Do not depend upon door switches or interlocks for protection but always shut down motor generators or other power equipment. Under no circumstances should any access gate, door, or safety interlock switch be removed, short-circuited, or tampered with in any way, by other than authorized maintenance personnel, nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

ALWAYS GROUND UNIT.

The power plug has an extension ground lead at its male end. This ground lead extension is on the power plug to prevent dangerous shock hazard. Do not operate or service this equipment without connecting this ground lead extension to a suitable ground. See Section 3 paragraph 2C.

RESUSCITATION

AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADIO, RADAR, OR SONAR ENCLOSURE. POSTERS MAY BE OBTAINED UPON REQUEST TO THE BUREAU OF MEDICINE AND SURGERY.

SECTION 4
OPERATION

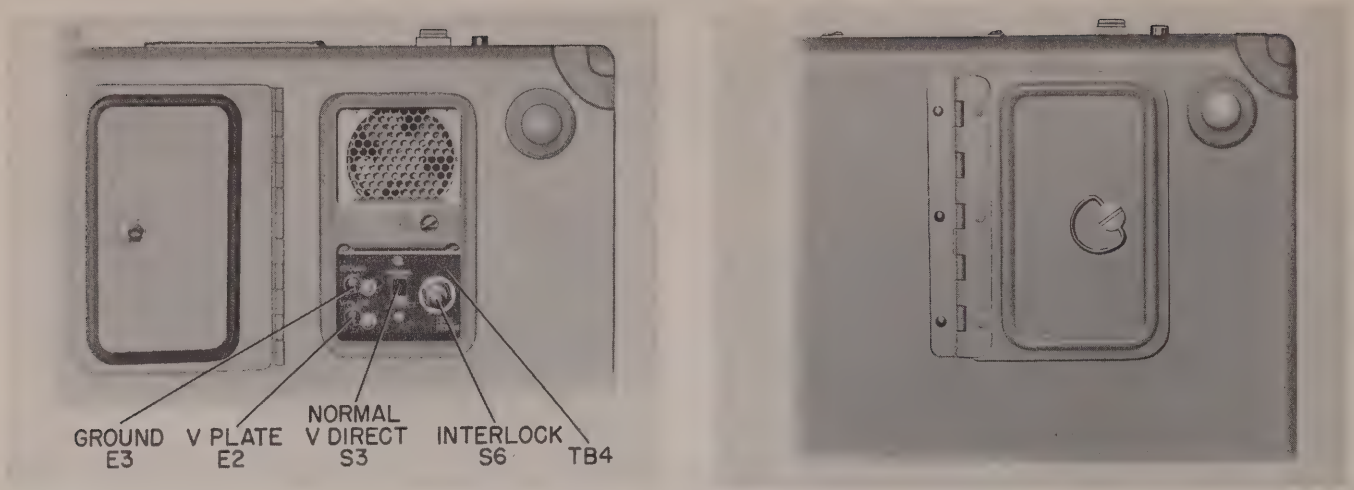
1. CONTROLS AND CONNECTORS.

All operating controls of this oscilloscope and means for making external connections are located on its front panel and rear of combination case, as shown in figure 4—1. The function of each control and connector is briefly explained in the following table. Supplementary explanations, if necessary, are given further in the chapter. (NOTE—Ground lead extension of power plug must be connected to ground to prevent shock hazard.)

TABLE 4—1. CONTROLS AND CONNECTORS

FRONT PANEL

NAME	SYMBOL	EXPLANATION
V INPUT	J1	Connector for connecting external signal to vertical channel
GND	E1	Binding post for connecting external ground
PROBE POWER	J2	Connector supplying heater, B+ and ground for test lead CG-1277/USM-24C
V MULTIPLIER	S1	Six position rotary switch for attenuating vertical input signal up to 300 to 1. (Calibrated as a multiplier for ease of calibrating signal amplitudes.)
V GAIN	R25	Potentiometer for adjusting gain of vertical channel. Attenuation range of 6 to 1
CAL	S2	Three position rotary switch, one position spring return, for comparative calibration of signal at vertical channel
CAL VOLTS	R79	Potentiometer providing accurate voltage for calibration of signal at vertical channel
HEATER-OFF-POWER	S5	Three position toggle switch for switching power to the oscilloscope, OFF, or to the standby internal ambient heater
POWER INPUT	J4	Connector for applying external power through power cable
4 AMP (FUSE)	F1 & F2	4 Amp fuses for oscilloscope protection
SPARES (FUSE)	F3 & F4	Spare fuses, for F1 and F2
105V-115V-125V	S8	Three position rotary switch for selecting proper line voltage input. Arranged with cover so that power plug must be removed before switch can be operated
V POS	R51A/B	Dual potentiometer for adjusting the trace on the cathode ray tube along the vertical axis
H POS	R196	Potentiometer for adjusting the trace on the cathode ray tube along the horizontal axis
SCALE ILLUMINATION	R98	Potentiometer with switch for adjusting brightness of graduated scale, or for complete dimming
FOCUS	R58	Potentiometer for focusing the trace on the cathode ray tube
BEAM	R62	Potentiometer for adjusting the intensity of the trace on the cathode ray tube
SWEEP OUTPUT	J9	Connector providing linear sweep signal generated within oscilloscope for external use



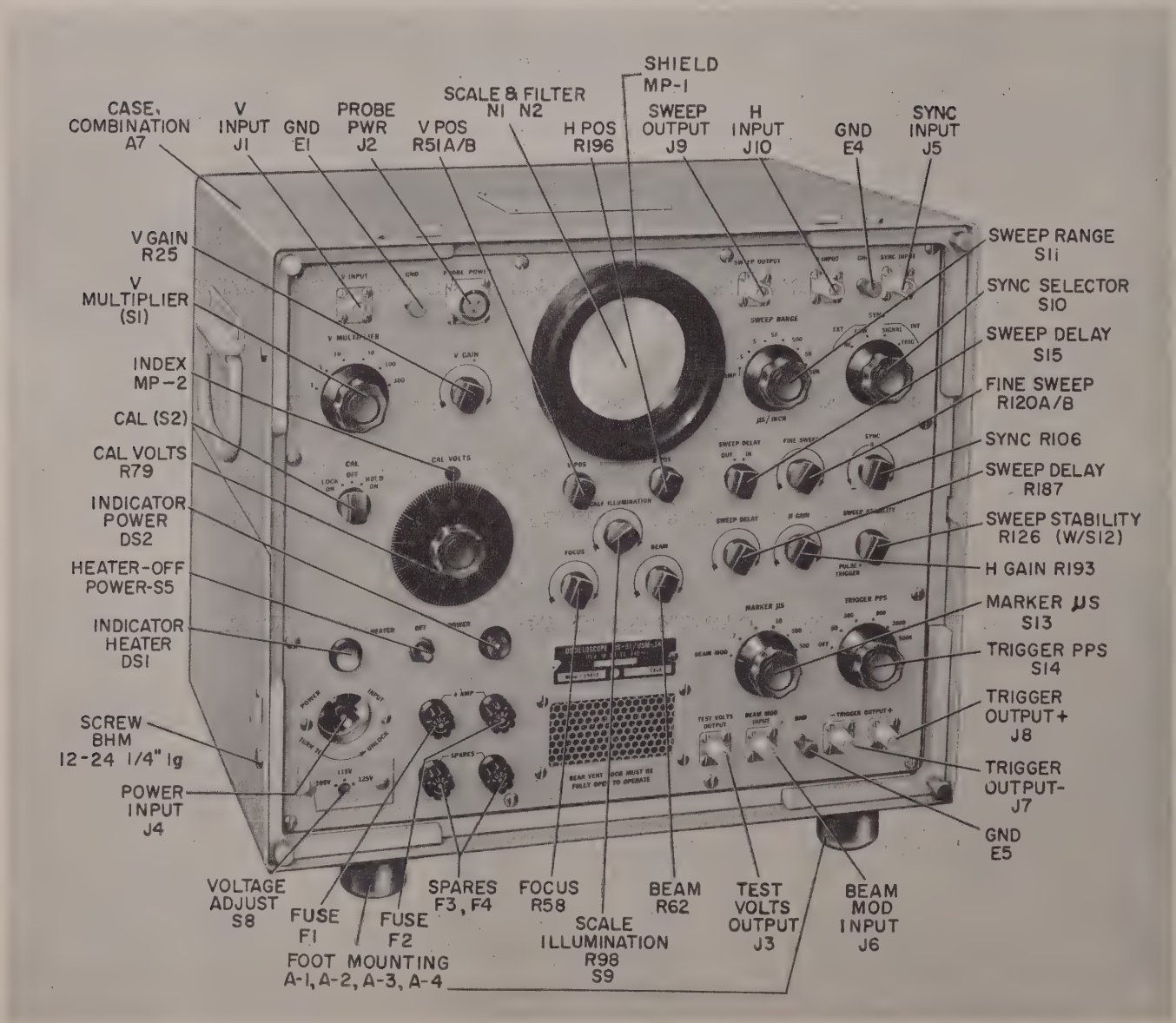


Figure 4—1. Front and Rear View of Oscilloscope OS-51/USM-24C Showing Controls and Connectors

TABLE 4—1. CONTROLS AND CONNECTORS—Continued
FRONT PANEL—Continued

NAME	SYMBOL	EXPLANATION
H INPUT	J10	Connector for connecting external signal to horizontal channel
GND	E4	Binding post for external ground
SYNC INPUT	J5	Connector for connecting external synchronizing signal to SYNC selector switch
SWEEP RANGE μS/INCH	S11	Six position rotary switch for selecting sweep lengths or external horizontal signal through J10
SYNC	S10	Four position rotary switch for selecting synchronization from internal SIGNAL or TRIG. or external HI (attenuation 30:1) or LOW level signals
SWEEP DELAY OUT-IN	S15	Two position rotary switch for introducing or removing delayed expanded sweep
FINE SWEEP	R120A/B	Dual potentiometer for adjusting the sweep lengths within the ranges of S11, SWEEP RANGE
SYNC	R106	Potentiometer for adjusting magnitude and polarity of the synchronizing signal
SWEEP DELAY	R187	Potentiometer for selecting the desired sweep delay (portion of sweep expanded)
H GAIN	R193	Potentiometer for adjusting the gain of the horizontal channel
SWEEP STABILITY	R126	Potentiometer for controlling the sensitivity of the sweep circuitry to provide periodic or trigger modes of operation and a snap switch position for selecting pre-set pulse trigger operation.
MARKER μS	S13	Six position rotary switch for selecting desired internal markers, or external BEAM MOD. signal from J6 for intensified marks on the CRT trace.
TRIGGER PPS	S14	Six position rotary switch for selecting desired internal trigger repetition rate
TEST VOLTS OUTPUT	J3	Connector for supplying externally 20 volts of calibration signal generated within oscilloscope
BEAM MOD INPUT	J6	Connector for applying external signal to intensity modulate the beam
GND	E5	Binding post for connecting external ground
—TRIGGER OUTPUT	J7	Connector for supplying externally, trigger pulses of negative polarity generated within the oscilloscope
+TRIGGER OUTPUT	J8	Connector for supplying externally, trigger pulses of positive polarity generated within the oscilloscope.
REAR OF COMBINATION CASE		
NORMAL V-DIRECT	S3	Two position slide switch for selecting either external direct signal from E2 or internally amplified (normal) signal to one vertical plate of the cathode ray tube
V-PLATE	E2	Terminal for connecting external signal directly to one vertical plate of the cathode ray tube through S3
GROUND	E3	Terminal, convenient to E2, for external ground
INTERLOCK	S6	Interlock to prevent power from being applied unless rear ventilation door is open

2. VOLTAGE, LOAD AND ENVIRONMENTAL LIMITS.

a. The total voltage to ground at any point to which the oscilloscope is connected should not exceed those voltages listed in table 4—2. These are the limiting voltages for which the oscilloscope and probes were designed. The total voltages include not only the signal component, but the DC level as well. No harm will be done to the oscilloscope by merely overloading the amplifiers and distorting the signal images, except that the BEAM MOD input should be kept at a point where there is no blooming of the image. Always start with the highest setting of the V MULTIPLIER when testing unknown voltages to prevent overloading of the VERTICAL PREAMPLIFIER, which could result in incorrect readings. Always use the highest position of the V MULTIPLIER that gives the desired amplitude of signal and do not display more than 1½ inches for a bidirectional signal or ¾ inch for a unidirectional signal such as a pulse.

Amplitude distortion, under many conditions, is not visible as waveform distortion and, therefore, this precaution should be observed continuously.

TABLE 4—2. VOLTAGE LIMITS

CONNECTOR	CONDITION	*SIGNAL PEAK VOLTAGE	*TOTAL PEAK VOLTAGE
V INPUT		150	400
V INPUT	With Test Lead CG-883A/USM-24	600	600
V INPUT	With Test Lead CG-1277/USM-24C	1	400
V DIRECT		150	+600 —160
H INPUT		55	400
SWEEP OUTPUT		20	DC Coupled
SYNC INPUT		150	150
SYNC INPUT	With Test Lead CG-883A/USM-24	450	600
TEST VOLTS OUTPUT		20	+250 —50
BEAM MOD INPUT		75	400
+TRIGGER		25-50	DC Coupled
—TRIGGER		25-50	+600 —200
POWER INPUT	ANY POSITION OF S8		5% of value marked on front panel

*Plus or Minus unless otherwise stated

b. In order to maintain maximum design parameters, without distortion or harming the operation of the oscilloscope, the external load impedances should follow those listed below. Whenever practicable, larger values of resistance and smaller values of capacitance should be used.

TABLE 4—3. OUTPUT LOADING

CONNECTOR	LOAD
SWEEP OUTPUT	50K ohm Min. Resistance 100 $\mu\mu$f Max. Capacitance
TEST VOLTS OUTPUT	250K ohm Min. Resistance 100 $\mu\mu$f Max. Capacitance
TRIGGER OUTPUT	500 ohm Min. Resistance 500 $\mu\mu$f Max. Capacitance

c. The oscilloscope will operate over an ambient temperature range from —54°C (—65°F) to 65°C (150°F) with humidity up to 95% at barometric pressures down to 20.6 inches (approximating an altitude of 10,000 feet). The oscilloscope will function properly after a warm up period up to 20 minutes, depending on the temperature. In cases of high humidity (75% to 95%) it is recommended that the oscilloscope be plugged in at all times, and power switch left on HEATER, dehumidifying the interior of the oscilloscope. The oscilloscope should be so placed that there is free circulation of air around it, with particular care taken so that the intake grille on the front, and ventilation door at the rear are free and have an adequate passage of air.

3. SWEEP CIRCUIT ADJUSTMENT.

a. The oscilloscope is designed to operate either periodically or triggered. The SWEEP STABILITY control changes the sensitivity of the circuit so that sweep may operate periodically with SYNC voltage controlling the operating frequency. Sweep can also be adjusted so that the sync or trigger voltage will cause the sweep to operate once for each sync or trigger pulse, providing the duty cycle is less than 50%.

(1) To operate in a periodic mode set the SWEEP RANGE to the desired range, set the SYNC selector switch to the desired source of synchronization and set the H GAIN approximately halfway. Rotate the SYNC control through its entire range and note the null point, and set the control at this point. When all of the steps have been followed rotate the SWEEP STABILITY control clockwise until a horizontal line appears. Check this position by rotating the SYNC control slowly through its null point. The horizontal line should remain.

(2) (a) To operate in a triggered mode set the SYNC control to its null point, and rotate the SWEEP STABILITY control counter-clockwise until the horizontal line disappears. Rotating the SYNC control toward the polarity indication that agrees with the trigger pulse being used should cause the horizontal trace to reappear and then disappear as the control is returned to the null point. Note: The internal trigger pulse is of + polarity.

(b) To operate in a triggered mode from standard pulses of 5 volts to 150 volts amplitude, rotate the SWEEP STABILITY control fully counter-clockwise to actuate the sweep switch. The scope is then ready to operate by setting the SYNC control to the sensitivity desired in the polarity direction that agrees with the polarity of the trigger pulse being used.

4. SWEEP INTERNALLY SYNCHRONIZED OR TRIGGERED BY SIGNAL.

Once the desired manner of operation has been established, as outlined in paragraph 3, the signal voltage can be used to control the sweep by setting the SYNC selector switch to INT SIG and adjusting the SYNC control in either direction. Turn the knob clockwise (+) to synchronize with the leading edge, or counter-clockwise (—) to synchronize with the trailing edge of the signal. In all cases, the minimum amplitude of sync consistent with a stable waveform should be used.

5. SWEEP EXTERNALLY SYNCHRONIZED OR TRIGGERED.

The sweep may be synchronized from any external source providing it meets the waveform, frequency and voltage requirements set forth in REFERENCE DATA, Table 1—4 in Section 1. Connect the external signal to the oscilloscope at the SYNC INPUT connector. Set the SYNC selector switch to EXT LOW if the signal is less than 5 volts, or to EXT HI if the signal is greater. As before, turn the SYNC control clockwise (+) to start the sweep at the leading edge of the sync signal and counter-clockwise (—) to start the sweep at the trailing edge of the external sync signal.

6. SWEEP SYNCHRONIZED OR TRIGGERED FROM INT TRIGGER GENERATOR.

The sweep may be controlled with the trigger pulses generated internally by setting the SYNC selector switch to INT TRIG., and setting the TRIGGER PPS switch for the desired rate. The SYNC control is operated as explained in paragraph 3 (2). These positive polarity pulses are available at 50, 300, 800, 2000 and 5000 pps. Pulses of either polarity can be used for triggering the equipment and are available at the trigger output connectors (J7 & J8). The waveform at the connectors is shown in figure 4—3. The trigger switch should be switched to its OFF position when the trigger signal is not being used.

7. SWEEP DELAY (EXPANSION).

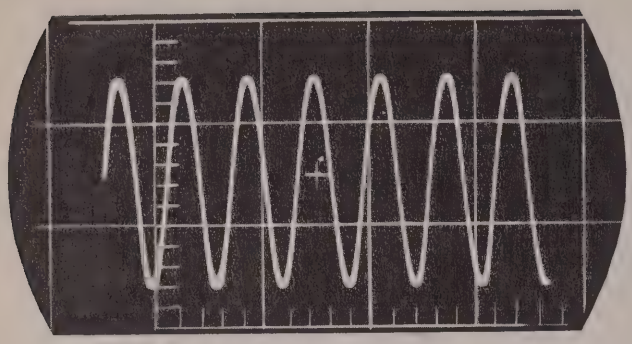
When it is desired to examine a small portion of the trace, turn the SWEEP DELAY switch to IN position. Rotate the SWEEP DELAY control until the desired portion is shown on the screen. This portion will be expanded approximately 10 times. The portion of the sweep time expanded and displayed advances from left to right with clockwise rotation of the control.

8. TIMING MARKERS.

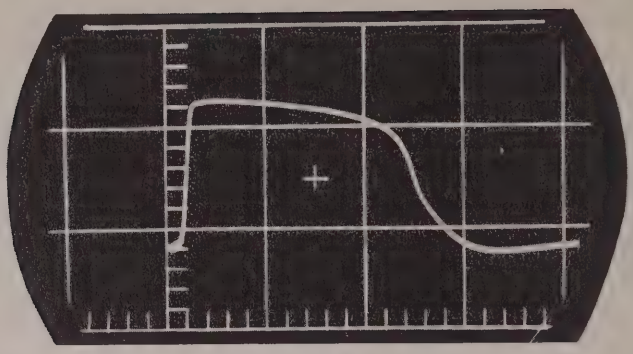
The time duration of signals displayed can be measured very accurately by means of marker pulses which appear as intensified dots along the trace (See figures 4—3*b* & 4—3*c*). These markers are generated internally and are available at five fixed rates (0.2, 1, 10, 100, and 500 microseconds). They are applied by setting the MARKER μS switch to the desired range and decreasing the BEAM control until they are of the desired visibility. They are of sufficient intensity to allow BEAM control settings so that they are visible only as a series of dots outlining the trace or as intensified dots on the trace. When not in use the MARKER μS switch should be left in the BEAM MOD position.

9. MEASUREMENT OF INPUT VOLTAGES.

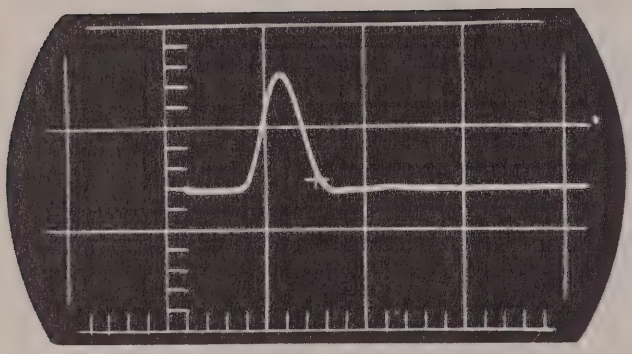
a. The amplitude of any vertical signal displayed on the screen of the cathode ray tube can be measured directly in peak to peak volts by the signal substitution method. Turn the SCALE ILLUMINATION control until the scale divisions are clearly visible. Adjust the V GAIN control so that the displayed signal is some convenient reference level and note the number of scale divisions the signal occupies. Do not adjust the image height greater than ¾ inch for a unidirectional pulse, or 1½ inches for the overall height of a bi-directional signal. Turn the CAL switch either to LOCK ON or HOLD ON positions, and adjust the CAL VOLTS control until the calibration signal occupies the same number of vertical divisions as the signal under test had. When desired, the CAL VOLTS signal can be repositioned by readjusting the V POS control. Do not change the setting of the V GAIN control. The peak to peak voltage of the signal under test is the



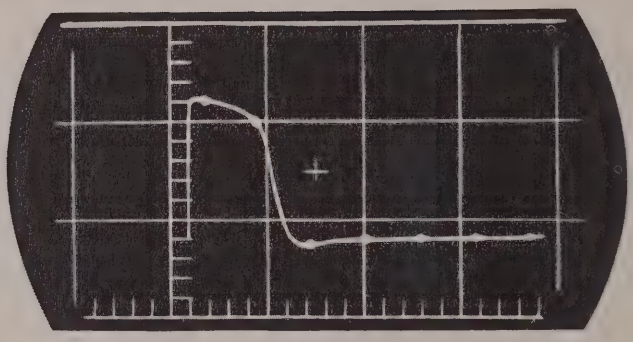
a. Sine Wave



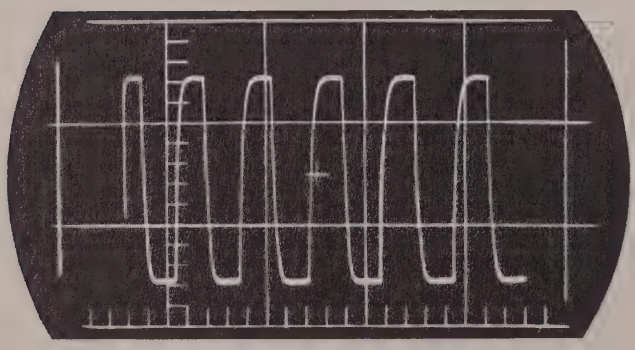
a. Trigger Pulse



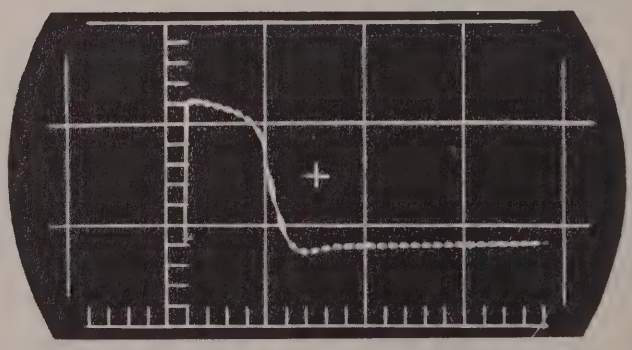
b. 0.1 Microsecond Pulse



b. Pulse and 1 Microsecond Markers



c. Calibration Voltage Waveform



c. Pulse and 0.2 Microsecond Markers

Figure 4—2. Examples of Cathode Ray Tube Patterns

Figure 4—3. Examples of Pulses and Timing Markers

reading on the CAL VOLTS dial times the V MULTIPLIER setting. If the Lead, Test CG-883A/USM-24 (10:1 ATTENUATION) is used, multiply the result by 10.

b. Another method of measuring input voltages is by calibrating the vertical channel. Turn the CAL switch so that the CAL voltage is displayed and adjust the CAL VOLTS dial to .5 volts. Adjust the V GAIN control to a convenient deflection such as one inch. Return the CAL switch to the OFF position and do not touch the V GAIN control. The Vertical Channel is now calibrated to 0.5 volts peak to peak per inch or 0.05 volts p-p per each small division on the graph screen. By manipulating only the V MULTIPLIER and noting the deflection, a wide range of signal amplitudes can be measured. For example: 7 divisions of deflection, when the V MULTIPLIER is at position 1, will be produced by an input signal of 7 x 1 x .05 or .35 volts. The same deflection would have been produced by input signal of 3.5 volts had the V MULTIPLIER been set at position 10. The vertical channel can be calibrated to any other sensitivity convenient to the operator.

When the 10:1 attenuator probe is used multiply the result by 10. The waveforms of the calibrating signal are shown in figure 4—2*c*.

CAUTION

Always read the image amplitude with the minimum beam intensity commensurate with readability. For accurate results read the amplitude from the center of the beam width at the signal peaks, not the outermost limits.

10. USE OF PROBES.

a. The use of probes increases the usefulness of the oscilloscope by permitting the observance and measurement of signals larger than can be handled directly, and they also introduce less loading to the signal source under test by increasing the shunt impedance. Paragraph 2, table 4—2 gives a listing of the voltage limits using the various accessory probes.

b. ATTENUATING PROBE CG-883A/USM-24.

This probe, schematically shown in figure 2—20, is an attenuating probe with a ratio of 10 to 1 attenuation, a high impedance input and low shunt capacity. It is used where signals to the vertical, horizontal, or synchronization channels are so large as to cause distortion and/or limiting of the signal in the input stage. When two of these probes are used simultaneously, in conjunction with connector UG-274/U, sufficient isolation is provided to permit mixing of the two voltages in order that both may be portrayed simultaneously. The probe may be connected to V INPUT, H INPUT or SYNC INPUT connectors.

Note

These probes are shipped from the factory with the trimmer capacitor adjusted for proper frequency response when connected to the V INPUT connector. If frequency response is important when the probes are used at other connectors, a small readjustment may be necessary. If very high signal levels are to be measured, so high that when attenuated by the probe and by the MULTIPLIER switch combined they are still above the safety limits as outlined in table 4—2, a voltage divider such as TS-89/AP may be used to decrease the signal. This will, in effect, extend the range of the oscilloscope in proportion to the factors of attenuation provided by the voltage divider.

c. TEST LEAD CG-1277/USM-24C.

This probe has an input impedance of 1 megohm paralleled by 11 micromicrofarads and can handle signal voltages up to 2 volts p-p. It is employed where the signal under test is small and the circuit under test is unable to tolerate loading. The probe has two connectors, one for the V INPUT jack, and the other for the PROBE POWER SUPPLY. As the probe uses a cathode follower to provide a high impedance to the signal source and a low impedance to the oscilloscope, it is essentially a low loss probe having an attenuation ratio of 1.66 to 1 or less.

11. VOLTAGE DIRECTLY TO V DEFLECTION PLATE.

It is possible to connect a test signal directly to the vertical deflection plate through terminals E2 and E3 on the rear of the oscilloscope by placing the slide switch in the V DIRECT position. Under this condition the internal signal sync is inoperative. The sensitivity of the oscilloscope in this condition is fixed and is about 110V peak to peak per inch. Signals from 20 to 300 volts peak to peak may be usefully applied. The actual sensitivity of the oscilloscope may be determined by applying an external signal of known amplitude directly to the deflection plate and interpolating from the measured deflection on the graph screen.

12. INSTANTANEOUS VOLTAGES TO GROUND.

This oscilloscope uses DC blocking capacitors at the input circuitry, and so, if it is desired to measure the test signal instantaneous voltage to ground, a suitable DC voltmeter may be connected across the measured load, and that voltage added to the oscilloscope measured voltage. In this operation, it is recommended that V POS be set to center and not disturbed. Then, the proper polarity can be added or subtracted to the voltmeter reading. The average DC voltage, read on the voltmeter, is represented on the oscilloscope by the horizontal line on which the trace rests when no signal is applied to the V INPUT. When a sine wave or other symmetrical waveform is displayed, this line will be centered between the peaks of the signal. When more complex waveforms are displayed, the pattern will be unbalanced with respect to this line. For a single cycle of the portrayed signal, the AREA of the signal above the line will be found to equal the

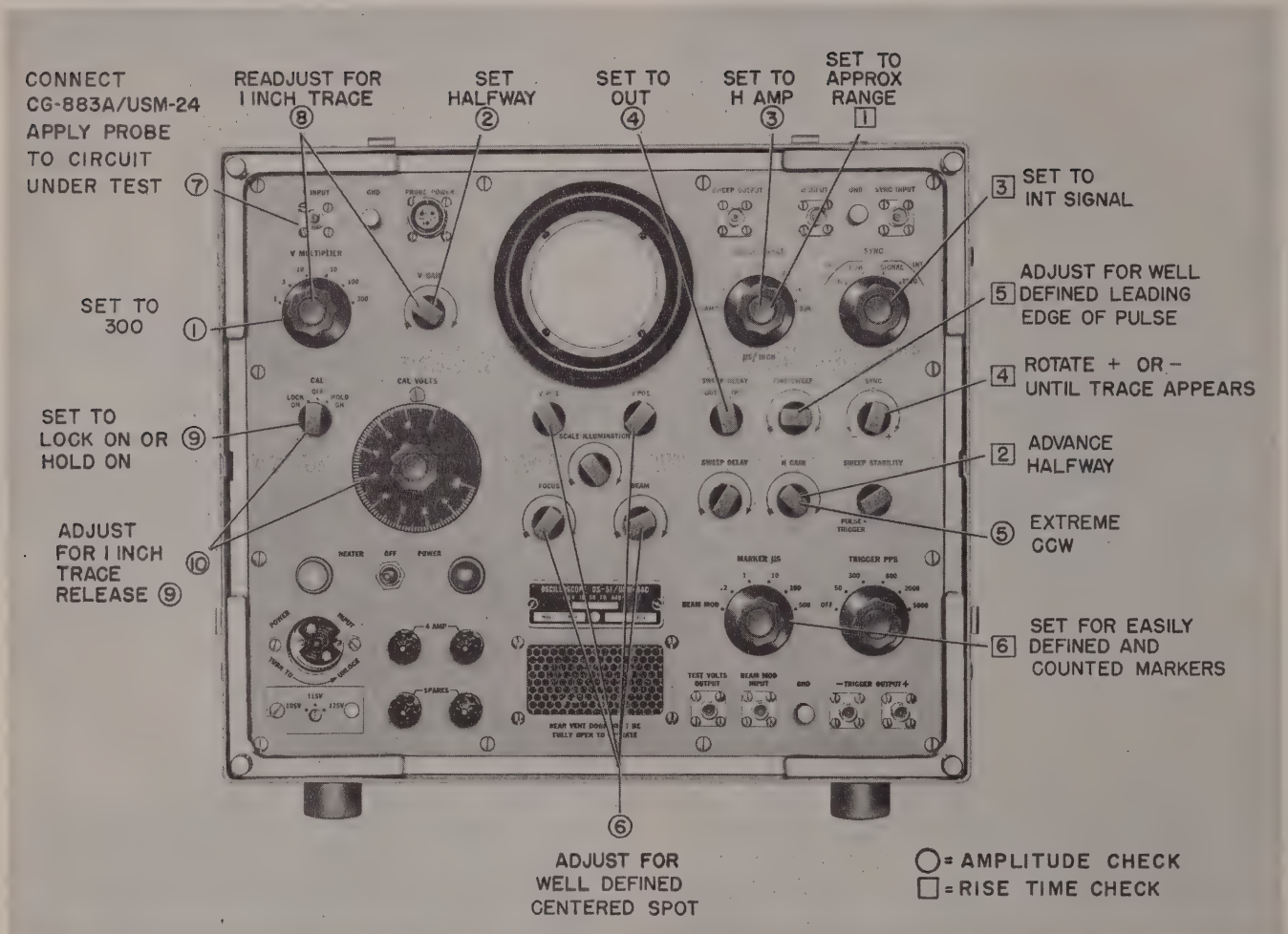


Figure 4–4. Control Settings for Basic Measurements

AREA of the signal below the line. It is necessary to avoid moving the V POS control during the measurement, once the average DC line is established. However, once the peaks of the pattern and the average DC line have been established, the V POS control can be used in conjunction with the CAL voltage control to measure both the positive and the negative peaks with reference to the average DC line. (See paragraphs 9 and 16 this section.) The algebraic sum of the positive peak voltage, the negative peak voltage and the DC meter voltage will be the measure of the instantaneous voltage to ground.

13. USE OF EXTERNAL SWEEP.

External sweep may be connected when the SWEEP RANGE switch is in the H AMP position. This voltage will be connected through the horizontal channel to the horizontal deflection plates. The circuitry is so connected that there is no phase reversal; positive going sweep will produce deflection from left to right. Sensitivity of the H INPUT is 3.6 volts rms per inch. The input impedance is 6.2 megohms paralleled by 47 micromicrofarads. When the external sweep is used, internal markers should not be used, as they are synchronized only with the internal sweep and the MARKER μS switch should be in BEAM MOD position.

14. SWEEP AVAILABLE EXTERNALLY.

When the oscilloscope is operated with internal sweep, the sweep voltage is available at the SWEEP OUTPUT connector. The circuitry is such that when proper load impedances are used, the operation of the oscilloscope will not be affected. The proper load impedances are 50,000 ohms minimum resistive and 100 micromicrofarads maximum capacitive.

15. EXTERNAL INTENSITY MODULATION.

External voltages for modulating the intensity of the electron beam may be applied to the BEAM MOD INPUT connector. The applied signal is amplified and coupled to the cathode of the display tube through the marker amplifier when the MARKER μS switch is in BEAM MOD position. As the applied pulses pass through one stage of amplification positive pulses at the input jack will intensify the beam and negative pulses will blank the beam. Signals applied should be in the range from 1.5 to 75 volts.

16. BASIC MEASUREMENTS.

This paragraph and figure 4—4 will serve to illustrate exact procedures for taking two basic measurements—the AMPLITUDE and RISE TIME of a pulse. The steps necessary for checking AMPLITUDE are indicated in figure 4—4 by circled (O) numbers, and the steps necessary for checking RISE TIME are indicated by blocked (□) numbers. Also see paragraph 8 and 9 for general information.

a. PULSE AMPLITUDE may be measured in the following manner:

(1) Set V MULTIPLIER to 300.

(2) Set V GAIN halfway.

(3) Set SWEEP RANGE to H AMP.

(4) Set SWEEP DELAY to OUT.

(5) Set H GAIN extreme counter-clockwise.

(6) Adjust BEAM, FOCUS, V POS and H POS for a well defined spot in the center of the screen.

(7) Connect Test Lead CG-883A/USM-24 to V INPUT and apply to circuit under test.

(8) Readjust V MULTIPLIER and V GAIN for 1 inch deflection.

(9) Set CAL switch to either HOLD ON or LOCK ON position.

(10) Adjust CAL VOLTS for 1 inch deflection. Return CAL switch to OFF position.

(11) Multiply the CAL VOLTS dial by the V MULTIPLIER setting. Multiply this figure by 10. (Test Lead CG-883A/USM-24 has a 10 to 1 attenuation factor).

b. RISE TIME can be measured in the following manner:

(1) Turn SWEEP RANGE switch to the range most likely to encompass the duration of the signal being observed. (Test Lead CG-883A/USM-24 connected to the circuit under test).

(2) Advance H GAIN control halfway.

(3) Set SYNC selector switch to INT SIGNAL.

(4) Advance SYNC control in + or — direction (depending on polarity of signal) until horizontal trace appears.

(5) Adjust FINE SWEEP control until leading edge of pulse is clearly defined. At this point it may be necessary to readjust the SYNC control.

(6) Turn MARKER μS switch until the markers which appear on the leading edge of the pulse are sufficient in number to be clearly defined and counted.

(7) Count the number of markers between 10% and 90% of the total pulse amplitude. Multiply this number by the number at which the MARKER μS switch has been set. The product will be an indication of the rise time, in microseconds, of the measured pulse. When comparatively fast rise times are to be measured, the rise time of the vertical channel of the oscilloscope should be considered. The rise time of the test pulse can be calculated using the formula:

$$R_p = \sqrt{R_o^2 - .0049}$$

where

R_p = rise time in μs of the *pulse* being measured.

R_o = rise time in μs *observed* on the scope.

.0049 = rise time squared in μs of the AN/USM-24C oscilloscope.

SECTION 5
OPERATOR'S MAINTENANCE

1. ROUTINE MAINTENANCE.

a. The useful life of this oscilloscope can be materially extended by using normal care when it is handled and operated. In so far as it is practical, the oscilloscope should be protected from dust and extremes in temperature. When not in use, the power should be disconnected from the oscilloscope unless climatic conditions require the use of the heater. When storing the unit, replace the accessories in their proper places in the Cover, Combination Case (CW-362/USM-24C) and place the cover on the oscilloscope. When in use, the area behind the oscilloscope should be clear to permit the free flow of air through the rear ventilating door. If the rear ventilating door can be fully opened (approximately 4 inches clearance) there will be enough air space in the rear of the oscilloscope for proper operation.

b. Before placing the oscilloscope in operation, check the voltage and frequency of the power source. The unit is designed to operate from a power source of 100 to 130 volts, 50 to 400 cycles per second. Table 5—1 indicates the proper setting of S8 voltage selector switch, (figure 4—1) for each range of line voltages. (NOTE—Always connect the ground lead extension in the power plug to a suitable ground).

TABLE 5—1. LINE VOLTAGE SELECTOR SWITCH SETTING

Line Voltage	*Switch Setting*
100-110 volts	105
110-120 volts	115
120-130 volts	125

For safety precautions, in order to set the voltage selector switch, the power cable must be removed from the POWER INPUT receptacle (figure 4—1), and the plexiglas cover swung upwards.

2. TABULATION OF FUSE LOCATIONS.

WARNING

Never replace a fuse with one of higher rating unless continued operation of the equipment is more important than probable damage. If a fuse burns out immediately after replacement, do not replace it a second time until the cause has been corrected.

TABLE 5—2. FUSE INFORMATION

(*See Figure 4—1*)

Fuse	*Location*	*Value and Function*
F2	Front Panel	4 amp-AC line protection
F1	Front Panel	4 amp-AC line protection

Note

There are two spare fuses contained in fuse holders XF3 and XF4 located below F1 and F2.

3. TUBE FUNCTION AND LOCATION.

Table 5—3 indicates the circuit and function of the tube complement. The figure number in column four indicates the illustration in Section 7 which shows the physical location of the tubes.

4. REPLACEMENT OF ELECTRON TUBES AND PILOT LAMPS.

WARNING

Be sure that power is disconnected before attempting to remove or replace any tubes. Dangerous voltages exist around all tube sockets.

a. REMOVING THE UNIT FROM THE COMBINATION CASE.

In order to remove any of the electron tubes or perform any other internal maintenance, the unit must first be removed from the combination case. This is done as follows:

(1) Remove all external connections attached to the unit.

(2) Carefully set the oscilloscope on its face.

(3) Remove the four rubber feet from the bottom of the combination case by removing the No. 12—24 screws which hold them.

(4) Remove a total of six No. 12—24 binding head machine screws located near the front edge of the top and each side of the combination case. (See figure 4—1).

(5) Slide the combination case off the unit. NOTE: The unit will not operate with the combination case removed due to S7, safety interlock switch, being open.

b. REMOVING THE CATHODE RAY TUBE.

(See figure 5—1 and 7—7)

(1) With power off, remove the intensifier connector from the side of the tube. This is a rubber covered clip fastened to an electrode near the screen end of the tube.

(2) Remove the tube socket (XV6) by pulling it firmly away from the tube base.

(3) Remove the two No. 6—32 binding head machine screws holding the tube clamp to the outer tube shield.

(4) Slide the tube, tube clamp and inner tube shield out of the outer tube shield.

(5) Loosen the No. 8—32 binding head machine screw holding the tube clamp to the tube. Remove the tube clamp.

TABLE 5—3. TUBE FUNCTIONS AND LOCATIONS

CIRCUIT SYMBOL	TUBE TYPE	FUNCTIONS	LOCATIONS FIGURE NO.
V1	JAN 6AH6	Vertical Preamplifier	7-20
V2A	1/2 JAN 12AU7	Internal Sync Take-off	7-20
V2B	1/2 JAN 12AU7	Delay Line Driver	7-20
V3	JAN 6AH6	Vertical Intermediate Amplifier	7-20
V4	JAN 6AN5WA	Vertical Grid-driven Amplifier	7-20
V5	JAN 6AN5WA	Vertical Cathode-driven Amplifier	7-20
V6	JAN 3JP1	Cathode Ray Tube	7-20
V7 A/B	JAN 12AU7	Calibration Generator, Grid-driven Multivibrator	7-27
V8	6203	Plate Supply Rectifier	7-27
V9	6203	Plate Supply Rectifier	7-27
V10	6203	Plate Supply Rectifier	7-27
V11	6203	Plate Supply Rectifier	7-27
V12	1V2	Positive High Voltage Rectifier	7-27
V13	1V2	Negative High Voltage Rectifier	7-27
V14A	1/2 JAN 12AT7WA	SYNC Cathode Follower	7-20
V14B	1/2 JAN 12AT7WA	SYNC Intermediate Amplifier and Phase Inverter	7-20
V15A	1/2 JAN 5726	SYNC Injection and Isolation Diode	7-20
V15B	1/2 JAN 5726	SYNC DC Clamp	7-20
V16A	1/2 JAN 12AT7WA	Gate Generator	7-20
V16B	1/2 JAN 12AT7WA	Parallel or SYNC Tube	7-20
V17A	1/2 JAN 12AU7	Gate Generator Cathode Follower	7-20
V17B	1/2 JAN 12AU7	Gate Generator Pulse Amplifier	7-20
V18A	1/2 JAN 12AT7WA	Marker Generator Injection and Isolation Diode	7-27
V18B	1/2 JAN 12AT7WA	Marker Generator Keying Tube	7-27
V19	JAN OA2WA	+150 Voltage Regulator	7-27
V20	JAN 6135	Marker Generator DC Setter	7-27
V21A	1/2 JAN 12AT7WA	Marker Pulse Generator	7-27
V21B	1/2 JAN 12AT7WA	Marker Pulse Amplifier	7-27
V22	JAN 6AH6	Marker Output Amplifier	7-27
V23 A/B	JAN 12AU7	Trigger Generator Blocking Tube Oscillator	7-27
V24	JAN 6135	Intensity Gate Amplifier	7-20
V25A	1/2 JAN 5726	Sweep Generator DC Clamp	7-20
V25B	1/2 JAN 5726	Sweep Gate DC Clamp	7-20
V26A	1/2 JAN 12AU7	Sweep Generator Cathode Follower and Bootstrap	7-20
V26B	1/2 JAN 12AU7	Sweep Generator Switch Tube	7-20
V27A	1/2 JAN 12AT7WA	Sweep Delay Cathode-driven Amplifier	7-20
V27B	1/2 JAN 12AT7WA	Sweep Delay Grid-driven Amplifier	7-20
V28A	1/2 JAN 12AU7	Horizontal DC Clamp	7-20
V28B	1/2 JAN 12AU7	Horizontal Amplifier	7-20
V29A	1/2 JAN 12AU7	Horizontal Grid-driven Output Amplifier	7-20
V29B	1/2 JAN 12AU7	Horizontal Cathode-driven Output Amplifier	7-20
V301	JAN 5719	Impedance Converter	7-9

CAUTION

The JAN 12AU7 used in this oscilloscope is not replacable with any other similar or ruggedized type tubes. Always replace a defective JAN 12AU7 with another JAN 12AU7 only.

(6) Remove the three shock mount grommets from the inner tube shield and slide the tube shield off the cathode ray tube.

c. REPLACING THE CATHODE RAY TUBE.

(1) Place the inner tube shield and tube clamps on the tube. Tighten the No. 8—32 binding head machine screws holding the tube clamp to the tube. Replace the three shock mount grommets on the inner tube shield.

(2) Insert the tube, inner tube shield and tube clamp into the outer tube shield until it is snug against the front retaining ring. Replace the two No. 6—32 binding head machine screws holding the tube clamp to the outer tube shield.

(3) Replace the intensifier connector.

d. ALIGNMENT OF THE CATHODE RAY TUBE.

(1) Put the oscilloscope into operation and adjust the controls to produce a sweeping trace (SECTION 3 Par. 2). The trace should sweep from left to right and be parallel with the horizontal lines on the graph screen. Note in which direction the tube must rotate to meet the above conditions.

(2) TURN OFF THE POWER. Loosen the No. 8—32 screw in the tube clamp and rotate the tube to the required position.

(3) Turn on the power and check the positioning.

e. REMOVING TUBES HELD BY TUBE SHIELDS.

(1) To remove the tube shield, press the shield downward and simultaneously turn it counterclockwise one-eighth turn. Slide the tube shield upward, away from the tube.

f. REMOVING TUBES HELD BY TUBE RETAINERS.

(1) To remove tubes held by the spring type tube retainers lift the coil spring at the center by exerting pressure away from the curled clip with a pencil or a similarly shaped tool. With finger and thumb on the glass envelope gently rock the tube and remove from socket.

g. REMOVING THE SCREEN ILLUMINATING LAMPS.

(1) Two lights are used to edge-light the graph screen. To remove the lamps slide the lamp sockets from the ears on the front end of the cathode ray tube shield.

(2) Press the lamp inward, at the same time rotate it a half turn counter-clockwise. Pull the lamp forward.

h. REMOVING RED AND WHITE PILOT LAMPS.

(1) Unscrew lens caps.

(2) Press lamp inward and at the same time rotate it a half turn counter-clockwise. Pull the lamp forward.

NOTE: The pilot lamps can be replaced with the unit in the combination case.

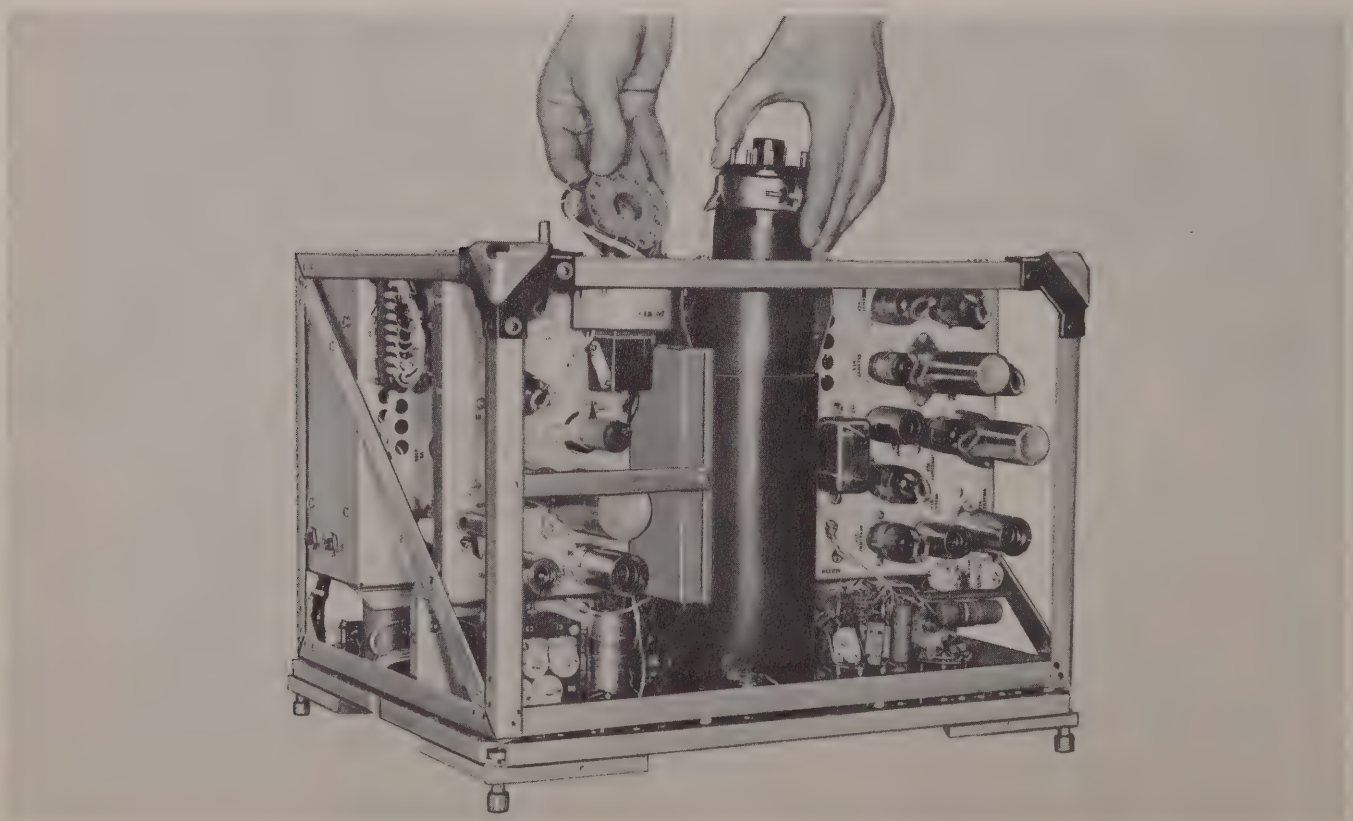


Figure 5—1. Removing the Cathode Ray Tube

SECTION 6
PREVENTIVE MAINTENANCE

1. MAINTENANCE PROCEDURE.

THE ATTENTION OF MAINTENANCE PERSONNEL IS INVITED TO THE REQUIREMENTS OF CHAPTER 67 OF THE BUREAU OF SHIPS MANUAL, OF THE LATEST ISSUE.

a. INSPECTION.

(1) Keep the oscilloscope clean by removing excess dirt and dust, in order to prevent faulty operation of the equipment.

(2) Check Test Leads CG-883A/USM-24 and CG-1277/USM-24C, Cable CG-409/U(8′0″) and the Power Cable CX-3092/USM-24C for deterioration of the plastic and rubber parts. Replace defective cords wherever possible.

(3) Check painted and plated surfaces for deterioration. Repaint wherever necessary.

(4) Check all rubber parts (shock mounts, rear door gasket, and front panel mount) for deterioration. Where possible, replace worn or deteriorated parts.

(5) Inspect blower motor brushes for excessive or uneven wear. Replacement of the brushes is explained in SECTION 7, (Paragraph 4*e*8).

b. CLEANING OF AIR INTAKE AND EXHAUST GRILLS.

To insure proper ventilation, the air intake grill on the front panel and air exhaust grill inside the rear vent door must be kept clean at all times. The grills may be kept clean by wiping the inner and outer surfaces with a damp cloth. (See SECTION 5, Paragraph 4 (a)).

c. CLEANING THE GRAPH SCREEN AND CATHODE RAY TUBE FACE.

To insure maximum light output and line definition of the cathode ray tube, both the graph screen and cathode ray tube face must be kept free of dust, which tends to collect on charged surfaces.

(1) Clean the cathode ray tube face with a clean, damp cloth, being sure to dry the tube thoroughly.

(2) The graph screen may be cleaned with any detergent. Do not use alcohol, acetone, kerosene, gasoline, carbon tetrachloride or paint thinner.

d. ELECTRICAL CHECKS.

All references below are to paragraphs located in SECTION 7.

(1) V Multiplier Compensation	3*a*(1)(*b*)
(2) Peaking adjustment of vertical amplifier	3*a*(3)(*b*)
(3) Marker accuracy	3*b*
(4) Trigger rate accuracy	3*e*
(5) Astigmatism adjustment	3*f*(2)
(6) Calibration Voltage adjustment	3*a*(5)
(7) Test Lead adjustment	3*g*

2. LUBRICATION.

No parts of the oscilloscope require periodic lubrication. The blower motor is lubricated at the factory for the life of the motor. Potentiometer shafts may be lubricated with Oil, Symbol S2075 (Standard Navy Stock Catalogue Number W S9150-235-5575 for 1 pint can, W S9150-235-5571 for 5 gallon can, W S9150-235-5573 for 55 gallon drum).

FAILURE REPORTS

A FAILURE REPORT must be filled out for the failure of any part of the equipment whether caused by defective or worn parts, improper operation, or external influences. It should be made on Failure Report, form DD-787, which has been designed to simplify this requirement. The card must be filled out and forwarded to BUSHIPS. Full instructions are to be found on each card.

Use great care in filling the card out to make certain it carries adequate information. For example under "Circuit Symbol" use the proper circuit identification taken from the schematic drawings, such as T—803, in the case of a transformer, or R—207, for a resistor. Do not substitute brevity for clarity. Use the back of the card to completely describe the cause of failure and attach an extra piece of paper if necessary.

The purpose of this report is to inform BUSHIPS of the cause and rate of failures. The information is used by the Bureau in the design of future equipment and in the maintenance of adequate supplies to keep the present equipment going. The cards you send in, together with those from hundreds of other ships, furnish a store of information permitting the Bureau to keep in touch with the performance of the equipment of your ship and all other ships of the Navy.

This report is not a requisition. You must request the replacement of parts through your Officer-in-Charge in the usual manner.

Make certain you have a supply of Failure Report cards and envelopes on board. They may be obtained from the nearest District Printing and Publication Office.

SECTION 7

CORRECTIVE MAINTENANCE

WARNING

BEWARE OF DANGEROUS VOLTAGES WHEN COVER IS REMOVED. INTERNAL ADJUSTMENTS OR TESTS WHICH DEMAND NORMAL OPERATION OF THE OSCILLOSCOPE SHOULD BE MADE WITH INSULATED TOOLS AND ONE HAND. KEEP OTHER HAND IN POCKET AND STAND ON A DRY BOARD OR LINOLEUM. DISCONNECT POWER CABLE FOR ALL OTHER MAINTENANCE WORK.

1. THEORY OF TROUBLE LOCALIZATION.

A thorough understanding of the operation of the oscilloscope, its basic principles and the functioning of its different circuits provides the best means for locating any trouble that may occur. This understanding can be had by carefully reading SECTIONS 1 and 2 of this manual. Trouble shooting should be carried out in a systematic manner, taking advantage of the Block Diagram (figure 7—45), the Schematic Diagram (figure 7—46) and the tube voltage and resistance charts (figures 7—16 to 7—18). In many cases it is possible to use self-contained means of testing the oscilloscope.

2. TROUBLE SHOOTING.

a. EQUIPMENT REQUIRED FOR TROUBLE SHOOTING AND MAINTENANCE.

A complete check of the oscilloscope, carrying out all of the tests outlined in this section, requires the use of the following test equipment.

(1) Another oscilloscope of the AN/USM-24C type.

(2) A non-electronic multimeter capable of reading AC and DC voltages up to 1000 volts, with an accuracy of 5%, having an input resistance of 20,000 ohms per volt on DC and 1000 ohms per volt on AC, and capable of measuring resistance up to 10,000,000 ohms, within an accuracy of 5%. A multimeter such as Multimeter AN/PSM-4 series is recommended.

(3) Electronic multimeter such as AN/USM-34, ME-25/U series or equivalent.

(4) A sine wave generator such as Signal Generator AN/USM-30 series, TS-382/U series or equivalent capable of producing frequencies of 50 to 200,000 cycles per second, within a frequency accuracy of 1%.

(5) A sine wave generator such as RF Signal Generator set AN/URM-25 series capable of producing frequencies of 0.5 to 15 megacycles per second within an accuracy of 1%.

(6) A square wave generator such as Square Wave Generator TS-583/U series or equivalent capable of producing accurately shaped flat topped waves of frequencies from 200 to 10,000 cycles per second with an output voltage adjustable from 0.5 to 75 volts peak-to-peak.

(7) A sweep generator similar to Model 1F Kay Marka-Sweep. It should cover a minimum range of 0 to 15 megacycles, and have a sweep width of 20 megacycles. It should have horizontal sweep output capable of driving the OS-51/USM-24C for at least 2 inches of horizontal trace (7.5 Volts r.m.s.).

(8) An absorption (grid-dip) meter covering a range of at least 1.7 to 12.5 megacycles, AN/PRM-10 or equivalent.

(9) A 500 ohm, ½W composition potentiometer.

(10) A resistance bridge such as RESISTANCE BRIDGE ZM-4/U.

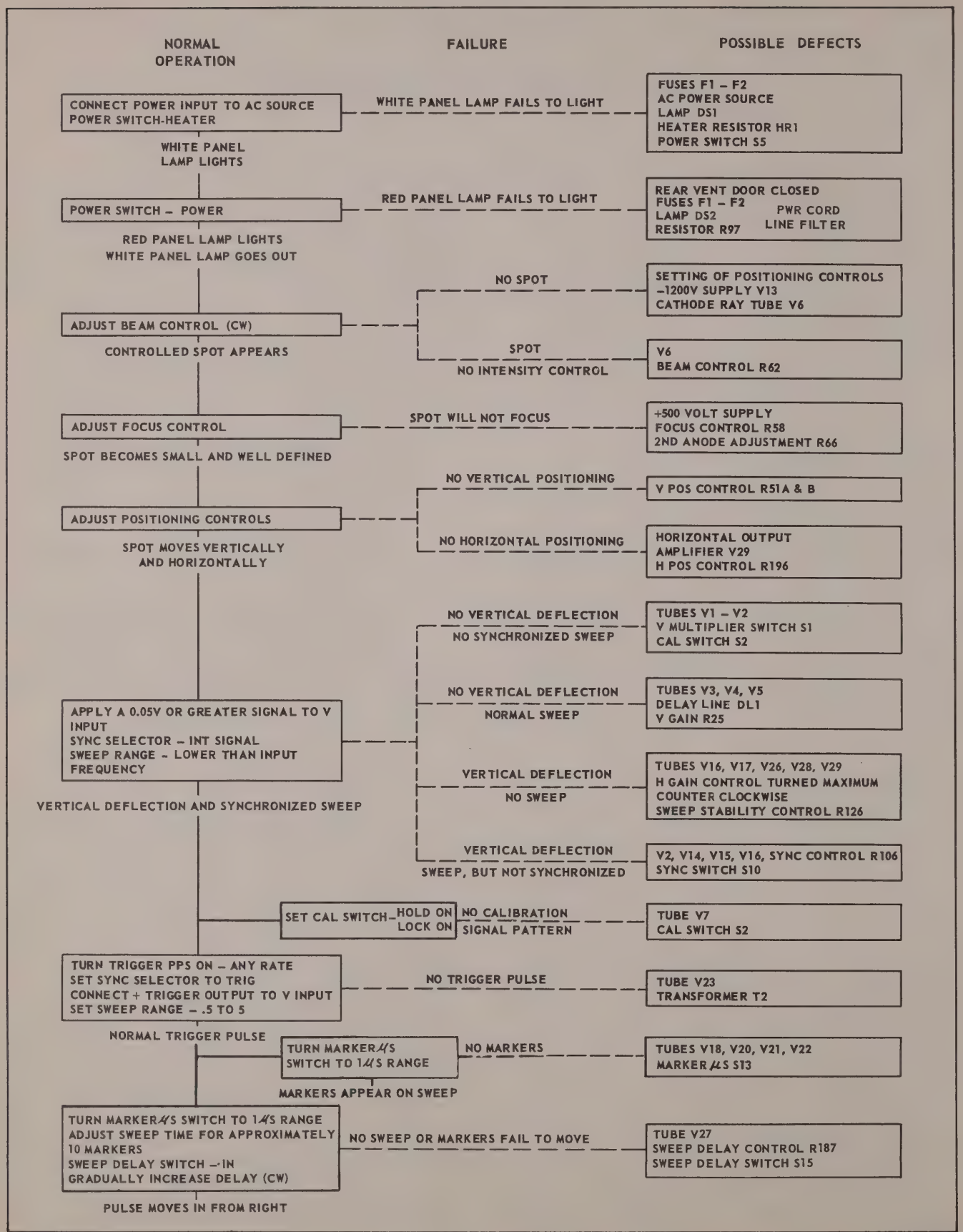
(11) A pulse generator capable of delivering pulses between 4 and 50V amplitude, with rise times of .02 μs or less and widths of approximately .25 μs. Includes means for varying repetition rates, as well as provisions for external synchronization at the rate of 800 pps.

(12) Tube tester—TV-3/U series.

b. USE OF MAINTENANCE INFORMATION.

The first step in correcting trouble is the recognition of its symptoms and the diagnosis of its cause. The following paragraphs deal with this subject. As a guide, a chart of troubles and their probable causes are given in table 7—1. Correction of troubles generally requires access to the insides of the oscilloscope and possible removal of an assembly to reach the defective part. Necessary instructions for this purpose are contained in paragraph 4, this section. Also included in this section are paragraphs indicating methods of testing and adjusting the special circuits contained in the oscilloscope. Pictures of normal waveforms of the voltages throughout the oscilloscope are shown in figures 7—10 through 7—15. Tables and diagrams of the voltages and resistances from tube pins to ground and other terminals, under no signal input conditions, are given in figures 7—16 through 7—18. This information should be used for checking the operation of, and for locating faulty components within, the circuits. For ease in locating components within a circuit, photographs of the interior of the oscilloscope and subassemblies, with components identified by their reference

TABLE 7—1. TROUBLE ANALYSIS CHART



symbol, are included in this section (figures 7—19 through 7—44). The Schematic Diagram (figure 7—46 and Wiring Diagrams (figure 7—47 through 7—49) are essential guides to circuit analysis and tracing. The Block Diagram (figure 7—45) should be of invaluable aid, since it includes such pertinent information as tube types, their circuit grouping, stage gain, input and output impedances as well as signal paths and control functions.

c. TROUBLE ANALYSIS CHART (TABLE 7—1).

A diagnosis of the cause of a trouble is usually possible from careful observation of the external symptoms shown on the cathode ray tube screen in response to the application of power and signal pulses and the operation of the front panel controls. Table 7—1 is a chart to facilitate such a diagnosis. It is based upon a normal sequence of operating steps. After each step the normal response is shown along the solid line which leads to the next step. If the response is abnormal, this is indicated along a dotted line leading to a list of probable causes of the malfunction. Without necessarily going through all of the steps, the chart may be consulted for an interpretation of an abnormal condition or response encountered while using the oscilloscope. Though most troubles will require tests inside the oscilloscope, much time can be saved by first narrowing the possible causes through careful analysis of all the trouble symptoms.

d. TABULATION OF SYMPTOMS, CAUSES AND REMEDIES (TABLE 7—2).

This tabulation presents another approach to the problem of localizing troubles. It is necessary, however, when using this chart that a careful comparison be made between the observed and charted symptoms. These are by no means the only troubles, with their accompanying causes and remedies, that can be encountered, but they do represent the more common types and thus can act as a guide to others not listed.

TABLE 7—2. TROUBLE SYMPTOMS, CAUSES AND REMEDIES

TROUBLE AND DIAGNOSIS	CAUSE	REMEDY
1. WHITE PILOT LAMP NOT LIT, POWER SWITCH IN HEATER POSITION	No AC power at source	Connect to energized outlet
	Defective power cable	Replace power cable or plug
	Fuse F1 or F2 blown	Replace fuse or fuses
	Lamp DS1 burned out	Replace lamp
	Resistor HR1 defective	Replace resistor
	Switch S5 defective	Replace switch (S5)
	Open circuited FL1	Replace FL1
2. RED PILOT LAMP NOT LIT, POWER SWITCH IN POWER POSITION	Rear vent door closed	Open rear vent door
	Lamp DS2, burned out	Replace lamp
	Resistor R97 defective	Replace resistor
	Fuse F1 or F2 blown	Replace fuse or fuses
	Transformer T1 defective	Replace transformer
	Open line filter FL1	Replace line filter FL1
3. NO SPOT, BEAM CONTROL MAXIMUM CLOCKWISE	Spot positioned off screen	Center spot, using V POS and H POS controls
	No second anode voltage	Check selenium rectifier CR2 and other components in +500V supply and replace defective parts (See SECTION 2 paragraph 9 for explanation of this circuit)
	No negative high voltage	Replace V13. If replacing tube does not correct trouble, check associated circuits and replace defective part.
	Defective cathode ray tube V6	Replace cathode ray tube

TABLE 7—2. TROUBLE SYMPTOMS, CAUSES AND REMEDIES—Continued

TROUBLE AND DIAGNOSIS	CAUSE	REMEDY
4. SPOT INTENSITY CANNOT BE CONTROLLED	Defective BEAM control R62	Replace defective control
	Defective cathode ray tube V6	Replace cathode ray tube
5. SPOT WILL NOT FOCUS	Defective FOCUS control R58	Replace defective control
	ASTIGMATISM control R50 or 2nd ANODE control R66 misadjusted	Adjust control
	Defective component in the negative high voltage bleeder	Replace defective part
6. SPOT CANNOT BE POSITIONED VERTICALLY	Defective V POS control R51A/B	Replace defective part
	Defective ASTIGMATISM control R50	Replace defective control
	Defective capacitors C20 or C21	Replace defective part
7. SPOT CANNOT BE POSITIONED HORIZONTALLY	Defective horizontal output tube V29	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective −200V supply	Check selenium rectifier CR3 and other components in the −200V supply and replace defective part
	Defective H POS control R196	Replace defective part
8. NO VERTICAL DEFLECTION, NO SWEEP WITH SUFFICIENT SIGNAL VOLTAGE APPLIED TO "V INPUT" AND "SYNC" SELECTOR IN "INT SIGNAL" POSITION	Defective vertical preamplifier tubes V1 or V2	Replace defective tube V1 or V2. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective V MULTIPLIER switch S1	Repair or replace switch assembly Z1 or switch S1
	Defective CAL switch S2	Replace defective switch
9. SWEEP, BUT NO VERTICAL DEFLECTION WITH SUFFICIENT SIGNAL APPLIED TO "V INPUT" AND "SYNC" SELECTOR SWITCH IN "INT SIGNAL" POSITION	Defective vertical intermediate amplifier V3	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part.
	Defective vertical output amplifier V4	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part.
	Defective DELAY LINE DL1	Replace DELAY LINE

TABLE 7—2. TROUBLE SYMPTOMS, CAUSES AND REMEDIES—Continued

TROUBLE AND DIAGNOSIS	CAUSE	REMEDY
10. INSUFFICIENT VERTICAL DEFLECTION	Defective V MULTIPLIER switch S1, or defective components associated with it	Replace or repair switch assembly Z1 or replace switch S1.
	Defective vertical output amplifier V5	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective DELAY LINE DL1	Replace DELAY LINE
11. NO SWEEP WHEN SIGNAL IS APPLIED TO SYNC AMPLIFIER	Incorrect setting of front panel controls	Check all front panel controls, especially H GAIN, R193, and SYNC selector switch S10
	If spot is intensified, trouble is probably in the linear sweep generator V26, or horizontal channel V28 and V29	Repair or replace defective tube or switch. If replacing tube does not correct trouble, check associated circuits and replace defective part
	If spot is not intensified, trouble probably is in SYNC selector switch, S10, sync amplifier, V14 and V15, or enabling gate generator, V16 and V17	
12. SWEEP WILL NOT SYNCHRONIZE	Defective sync amplifier V14	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective isolation and injection diode V15A	Replace defective tube V15. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective −200V supply	Check CR3 and other associated components and replace defective part
13. SWEEP TIME ABNORMAL, ONE RANGE	Timing capacitor associated with that range defective (C55, C56, C57, C58, C59)	Replace defective part
14. SWEEP TIME ABNORMAL, ALL RANGES	Defective tube V17	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective FINE SWEEP control R120A/B or resistor R119	Replace defective part
15. INSUFFICIENT HORIZONTAL DEFLECTION ONE RANGE	Defective sweep amplitude capacitor (C87, C88, C89, C90, C91)	Replace defective part

TABLE 7—2. TROUBLE SYMPTOMS, CAUSES AND REMEDIES—Continued

TROUBLE AND DIAGNOSIS	CAUSE	REMEDY
16. INSUFFICIENT HORIZONTAL DEFLECTION ALL RANGES a. With SWEEP RANGE switch set to H AMP position, and an external signal of 7.5V rms applied to H INPUT, less than 2 inches of horizontal trace is obtainable	Defective horizontal amplifier V28	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective horizontal output amplifier V29	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective H GAIN control R193	Replace defective part
b. If above test gives 2 inches of horizontal trace, trouble is probably:	Defective linear sweep generator tube V26 or gate generator tube V16	Replace defective tube V26 or V16. If replacing tube does not correct trouble, check associated circuits and replace defective part
	FINE SWEEP control R120A/B or resistor R175	Replace defective part
17. NO SWEEP WITH "SWEEP DELAY" SWITCH S15 IN "IN" POSITION	Defective sweep delay generator tube V27	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective SWEEP DELAY switch S15	Replace defective part
18. NO SWEEP DELAY CONTROL WITH "SWEEP DELAY" SWITCH S15 POSITIONED TO "IN" POSITION	SWEEP DELAY potentiometer R187 defective	Replace defective part
	Defective +150V supply	Replace defective associated components
	Defective SWEEP DELAY Switch S15	Replace defective part
19. NO MARKERS ONE RANGE	Defective timing capacitors (C64, C65, C66, C68, C69, C70)	Replace defective part
	Defective timing resistors (R141, R142, R143, R144, R209)	
	Defective MARKER μS Switch (S13)	
20. NO MARKERS ALL RANGES	Defective marker generator, V21	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective marker amplifier, V22	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part
	Defective dc level tube, V20	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part

TABLE 7—2. TROUBLE SYMPTOMS, CAUSES AND REMEDIES—Continued

TROUBLE AND DIAGNOSIS	CAUSE	REMEDY
21. MARKERS NOT SYNCHRONIZED WITH SWEEP	Defective MARKER μS Switch (S13)	Replace defective part
	Defective marker gen. keying tube V18B	
	Improper setting of DC LEVEL ADJ. R135	Reset adjustments as outlined in SECTION 7 Par. 3b
	Improper setting of KEYING GATE ADJUSTMENT R130	
22. NO TRIGGER VOLTAGE, ONE RANGE	Defective Switch S14	Replace complete switch assembly Z4 or switch S14. *(See Note below.)
	Defective timing resistor (R161, R162, R163, R164, R165)	Replace defective part
23. NO TRIGGER VOLTAGE ALL RANGES	Defective trigger generator tube V23	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace defective part. Adjust trigger rate per SECTION 7 Par. 3*e*
	Defective pulse transformer T2	Replace defective part. Adjust trigger rate per SECTION 7 Par. 3*e*
24. NO CALIBRATION VOLTAGE AT "TEST VOLTS OUTPUT" J3	Defective calibration generator tube V7	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace part
25. NO CALIBRATION VOLTAGE SHOWN WHEN "CAL" SWITCH S2 IS IN "HOLD ON" OR "LOCK ON" POSITION	Defective calibration generator tube V7	Replace defective tube. If replacing tube does not correct trouble, check associated circuits and replace part
	Defective CAL switch S2	Replace switch
	Defective CAL VOLTS control R79, or adjusting controls R78 and R80	Replace defective part
26. NO SCALE ILLUMINATION	Defective SCALE ILLUMINATION switch S9, attached to R98	Replace defective part
	If scale is lit, on one side only, one lamp may be defective	Replace defective lamp

*Note: AN/USM-24C's prior to Serial 751 have TRIGGER switch (S14) with one less contact and the trigger timing capacitor (C81) has a value of 6800 $\mu\mu$f.

AN/USM-24C's after Serial 750 have TRIGGER switch with one more contact and the trigger timing capacitor has a value of 5100 $\mu\mu$f.

All replacement switches (S14) have the additional contact and when switch replacement is made, capacitor C81 must be changed to the present value of 5100 $\mu\mu$f.

All replacement switch assemblies (Z4) include TRIGGER switch S14 having one more contact, and capacitor C81 which has a value of 5100 $\mu\mu$f. When switch assembly Z4 is replaced, the circuit is automatically brought up-to-date. Check and adjust trigger rate per SECTION 7 Par. 3*e*.

3. ADJUSTMENTS AND REPAIRS.

a. VERTICAL CHANNEL.

(1) V MULTIPLIER (figure 2—6). Each step of the V MULTIPIER switch (except position 1) sets up a voltage divider which reduces the input signal by a factor equal to the number shown opposite the switch position. In order to reduce high and low frequencies equally, it is necessary that the same proportion of resistance and capacitive reactance be maintained in the series and shunt arms of the V MULTIPLIER.

(*a*) RESISTANCE CHECK.

Equipment Required:

Resistance bridge ZM-4/U or equivalent.

The resistors which are assembled into the V MULTIPLIER are within one percent of their nominal value as shown on the Schematic Diagram (figure 7—46). If the equipment necessary to check these resistors, such as Resistance Bridge ZM-4/U, is not available, it is recommended that the resistors not be replaced until exhaustive checks of the balance of the V MULTIPLIER circuits show them to be out of tolerance. A check of the overall resistance to ground can be made from the V INPUT connector without removing the oscilloscope from its combination case. The maximum and minimum permissible values of the resistance for each position of the V MULTIPLIER switch (S1) are tabulated below:

TABLE 7—3. RESISTANCE CHECK OF V MULTIPLIER

STEP	RESISTANCE TO GROUND FROM CENTER TERMINAL OF V INPUT (J1)	
	Max.	*Min.*
1	351,500	344,500
3	308,000	302,000
10	303,000	297,000
30	303,000	297,000
100	303,000	297,000
300	304,000	298,000

(*b*) CAPACITOR ADJUSTMENT.

Equipment Required:

Square Wave Generator TS-583/U per SECTION 7 Par. 2*a*(6).

Each step of the V MULTIPLIER, except step 1, contains a fixed capacitor in the shunt arm and a variable capacitor in the series arm. Step 1 itself is not a voltage divider but becomes one only when Test Lead CG-883A/USM-24 is connected to the V INPUT connector. The variable capacitors are adjusted so that the capacitance ratios of the series and shunt arms of the V MULTIPLIER are exactly the inverse of the resistance ratios. This is done as follows:

1. Apply a 10KC square wave to the V INPUT connector.

2. Set the V MULTIPLIER switch to the range which is being adjusted.

3. Adjust the output of the square wave generator to produce a vertical pattern of approximately one inch. The V GAIN control should be set near maximum, but care should be exercised to avoid overloading the amplifier. Adjust the sweep controls to view approx. 3 cycles of the square wave.

4. Adjust the variable capacitor associated with the range being adjusted until the waveform on the screen of the cathode ray tube appears as shown in figure 7—1. The tabulation below indicates which capacitor to adjust for each range.

TABLE 7—4. CAPACITOR ADJUSTMENT OF V MULTIPLIER

STEP	CAPACITOR TO ADJUST
1	None
3	C5
10	C4
30	C3
100	C2
300	C1
1—Test Lead CG-883A/USM-24	C301

(2) SENSITIVITY AND GAIN CONTROL OF THE VERTICAL CHANNEL

Equipment Required:

Sine Wave Audio Frequency Signal Generator per SECTION 7 Par. 2*a*(4).

(*a*) The voltage necessary to produce one inch of deflection is a measure of the signal channel sensitivity. Included in this measurement is the deflection sensitivity of the cathode ray tube and the overall gain of the vertical channel. The vertical channel has a gain of approximately 655. This means, with a cathode ray tube having a deflection sensitivity of 110 V peak to peak per inch (this is the average deflection sensitivity of a JAN 3JP1, as operated in this equipment), the input signal to produce a one inch deflection is 0.06 V rms, when the V MULTIPLIER is set at 1. These tests are made with a 1000 cps signal. If the sensitivity is low; that is, if more than 0.06 V rms is required to produce a deflection of one inch, the tubes of the vertical channel (V1, V2, V3, V4, and V5) should be changed one by one, checking the sensitivity after each change. (Be sure to replace each tube with the original if the trial indicates it is not defective). If replacing the tubes does not restore the sensitivity, the signal waveforms at the tube sockets should be checked with another oscilloscope of the AN/USM-24C type and compared to the waveforms illustrated in figure 7—10*a*.

(*b*) A continuously variable V GAIN control (R25) is included in the vertical channel to provide attenuation in addition to the V MULTIPLIER. The V GAIN control should provide an attenuation range of approximately 6 to 1. This range can be checked by

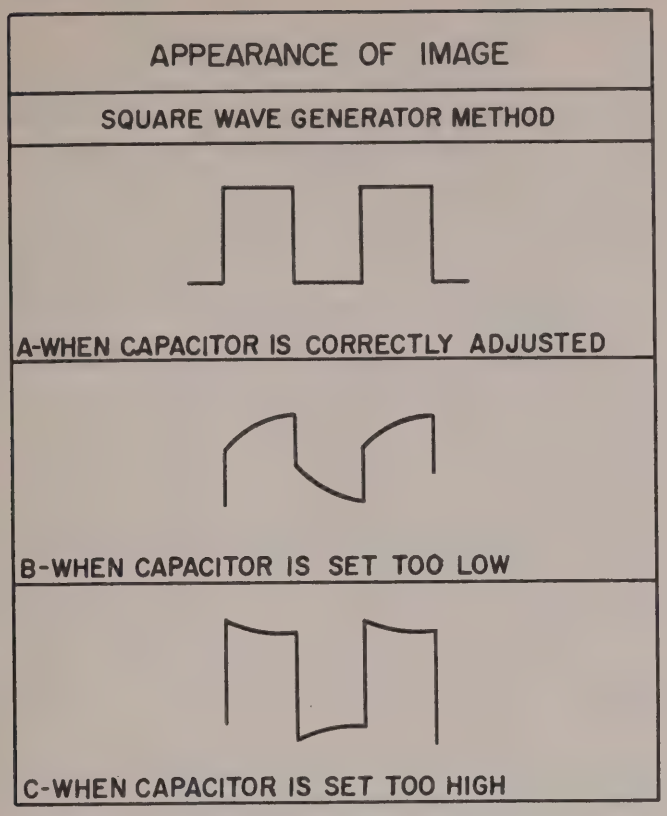


Figure 7—1. Waveform Guide for Adjustment of V MULTIPLIER and Test Lead CG-883A/USM-24 Capacitor

applying the calibration voltage to the amplifier, adjusting the CAL VOLTS control (R79) for one and a half inch deflection (15 divisions on the graph screen) with the V GAIN control maximum clockwise. Then turn the V GAIN maximum counterclockwise. The deflection should now read approximately two and one half divisions.

(3) FREQUENCY RESPONSE OF THE VERTICAL CHANNEL. Figure 2—5 shows a typical frequency response curve. This can be checked by supplying a constant voltage at a number of frequencies and noting the amplitude of deflection on the screen of the cathode ray tube for each. If the response curve is to be accurate a large number of frequencies must be plotted, making this a difficult and time consuming task. It is possible to check the frequency response much more readily. The procedure is as follows:

(*a*) LOW FREQUENCY RESPONSE.

Equipment Required:

Square Wave Generator TS-583/U per SECTION 7 Par. 2*a*(6).

To check the low frequency response of the vertical channel, the square wave method is used. Apply a 200 cycle flat topped wave to the V INPUT. Set the V GAIN control at or near maximum clockwise and adjust the V MULTIPLIER and the output of the square wave generator for a deflection of 10 divisions (1 inch). Set the SWEEP RANGE switch (S11) and the FINE SWEEP control (R120A/B) for a display of several cycles. Observe the waveform presented on the cathode ray tube screen and note any departure from flatness at the top of the wave. There should not be more than one half division departure. If the signal channel does not meet this requirement, one or more of the following resistors or capacitors is either defective or has changed value: C11, C13, C14A, C16, C17, C18, C19, C20, C21, C103A, C103B, R12, R15, R18, R27, R34, R48 or R49.

(*b*) HIGH FREQUENCY RESPONSE.

Equipment Required:

RF Signal Generator AN/URM-25 per SECTION 7 Par. 2*a*(5).

To check high frequency response of the vertical channel, an RF signal generator with metered output should be used such as Signal Generator AN/URM-25. Apply the RF signal to the V INPUT with V MULTIPLIER in the 1 position, V GAIN at or near midposition and the SWEEP RANGE switch in the H AMP position. Set the RF generator at 0.5 megacycles and vary the generator output until a deflection of one inch is obtained. Note the meter reading of the RF generator and maintain this output reading for all frequency settings. Check the relative response against all frequencies up to 10 megacycles in one half megacycle steps. Compare the results against the typical frequency response curve figure 2—5. If the response curve is excessively peaked at any point, or the response is down over the entire range, the peaking coils should be readjusted.

CAUTION

Adjusting the peaking coils is a difficult operation which has been done at the factory. The adjustment of these coils should not be tampered with unless the evidence shows clearly that the high frequency response of the vertical channel is unsatisfactory, and cannot be corrected in any other manner.

The effect of defective components, other than peaking coils, on the amplifier frequency response can easily be misinterpreted. The increase in value of one plate load resistor, for instance, may reduce the high frequency response and give the appearance of peaking coil misalignment. An open bypass capacitor often effects the response in such a manner that it appears that the high frequencies are over compensated. Replacement with the proper value will return the response to normal, provided the peaking coils have not been mistakenly misadjusted. Changes in tube characteristics may likewise be misleading.

When a single tube is replaced it should not be necessary to recompensate the amplifier, provided the new tube is within JAN limits. In the event that a peaking coil is found defective and replaced, only that particular coil should be adjusted.

1 SINE WAVE AUDIO FREQUENCY SIGNAL GENERATOR METHOD OF PEAKING COIL ALIGNMENT.

(This method is not recommended except under circumstances when the equipment used in SECTION 7 Par. 3 (2) is not available). Equipment Required:

RF Signal Generator AN/URM-25 per SECTION 7 Par. 2*a*(5).

This method of peaking coil alignment may not result in optimum pulse response characteristics but is included to permit the continued use of the oscilloscope until it can be checked as outlined in SECTION 7 Par. 3(2).

The alignment of the peaking coils may be done as follows:

a Set front panel control as follows:

Control	*Setting*
V MULTIPLIER	1
V GAIN	Mid position
SWEEP RANGE	A convenient number of cycles

b Set cores of all peaking coils (L1, L2, L3, L4, L5 and L6) for minimum inductance.

c Remove *both* of the leads connected to the delay line and temporarily solder them together.

d Connect the metered output of an RF signal generator to the center terminal of the V GAIN control. Adjust the RF output for a one inch deflection at 1 MC. Note the RF meter reading and maintain this output for all other frequency settings.

e Set the output of the RF generator to 12 MC and adjust the core of L6 for 0.25 inches deflection.

f Set the output of the RF generator to 10 MC and adjust the core of L5 for a deflection of 0.35 inches.

g Reset the output of the RF generator to 4 MC and readjust L3 and L4 for maximum deflection, but not to exceed 1.05 inches. Back off on the core screw if necessary. Adjust L3 and L4 alternately so that the final settings are approximately equal.

h Reset the output of the RF generator to 7 MC and readjust L2 for 0.6 inch deflection. Recheck steps *e* to *h* inclusive.

i Reconnect the output of the RF Signal Generator to the V INPUT connector and readjust its output for a one inch deflection at 1 MC. Note the RF meter reading and maintain this output for all other frequency settings.

j Reset the RF generator to 8 MC and adjust the core of L1 to obtain a deflection of 0.75 inches.

k Tighten the lock nuts on all of the tuning cores making sure the adjustments are not disturbed.

l Reconnect the wire lead to the lower terminal, and the coil lead to the upper terminal of the delay line.

2 SWEEP GENERATOR AND PULSE GENERATOR METHOD OF ALIGNMENT. (This is the preferred method of alignment to produce optimum pulse response). Equipment Required:

Sweep Generator per SECTION 7 Par. 2*a*(7).

Absorption Meter per SECTION 7 Par. 2*a*(8) or an RF Signal Generator AN/URM-25 per SECTION 7 Par. 2*a*(5).

Pulse Generator per SECTION 7 Par. 2*a*(11).

Two Binding Post Adapters type UG-924/U.

a Connect the sweep generator to the oscilloscope as follows:

(1) Connect a binding post adapter type UG-924/U to the V INPUT connector (J1).

(2) Connect an insulated wire from the output of the sweep generator to the V INPUT. Make a two or three turn wrap of this wire around the coil of the absorption meter. If the signal generator is used instead of the absorption meter, couple it loosely to the input by using a two or three turn loop of wire inductively coupled to the coiled turns on the sweep generator lead.

(3) Connect a ground wire from the sweep generator to the vertical ground connector on the oscilloscope.

(4) Connect a wire from the sweep signal output (horizontal) on the sweep generator to the H INPUT (J10) on the oscilloscope. This will require the use of another adapter UG-924/U.

b Set the controls of the sweep generator as follows:

(1)	Sweep width	approx. 12 megacycles
(2)	Channel Switch	To cover a range of 0 to 12 megacycles
(3)	Phase	Adjust for proper phasing of horizontal signal
(4)	Blanking	ON
(5)	Attenuator controls	for usable deflection on cathode ray tube.

c Set the controls of the oscilloscope as follows:

(1)	V MULTIPLIER	1
(2)	V GAIN	Mid Position
(3)	SWEEP RANGE	H AMP
(4)	H GAIN	Adjust for 2 inch deflection

d Preliminary procedure of peaking coil alignment using a sweep generator.

(1) Adjust attenuator controls of the sweep generator for ½ inch deflection on the low frequency end of the sweep (see response curve Fig. 7—10*b*).

(2) Set all peaking coils (L1, L2, L3, L4, L5 and L6) so that their cores are all the way out.

(3) Adjust L5 and L6 for maximum signal amplitude at 10 and 11 megacycles peaks (use absorption meter to determine proper peaks).

(4) Adjust L3 and L4 for maximum signal amplitude at 10 megacycles peaks (use absorption meter to determine proper peaks).

(5) Adjust L1 for a straight slope of the curve between 6.5 and 10 megacycles.

(6) Adjust L2 for a straight slope of the curve between 3.5 and 6.5 megacycles.

(7) If necessary, readjust L1 for a straight overall slope.

(8) Disconnect the sweep generator from the setup.

e Final procedure of peaking coil alignment using a Pulse Generator.

(1) Set the oscilloscope TRIGGER PPS to 800 and connect the + TRIGGER OUTPUT (J8) to the TRIGGER IN terminals of the pulse generator.

(2) Set the pulse generator controls as follows:

Control	*Setting*
TRIGGER IN	+
PULSE RATE	External Trigger
PULSE POLARITY	+
PULSE WIDTH	0.25 Microsecond

(3) With the pulse generator properly terminated connect the PULSE OUTPUT to V PLATE terminal of the oscilloscope with the NORMAL-V DIRECT switch (S3) set to V DIRECT. Adjust the SWEEP RANGE to .5-5 position, the FINE SWEEP control until the pulse appears approximately 3/8" wide at its base and the SYNC control for best operation.

(4) Observe the pulse shape for reference.

(5) Remove the pulse from the V-PLATE terminal and return the NORMAL-V DIRECT switch to NORMAL.

(6) Reduce Pulse Generator output to approximately 4 Volts.

(7) Set V MULTIPLIER to 30 and readjust FINE SWEEP until the pulse occupies approximately the same position on the screen as when viewed direct.

(8) Trim core of coil L5 until overpeaking is noticed on leading edge of pulse. Back off from this point until the pulse is similar to that observed in (4) above. (This adjustment affects the top front and top rear edge of the pulse shape.)

(9) Trim core of coil L6 until overpeaking is noticed on leading edge of pulse. Back off from this point until the pulse is similar to that observed in (4) above.

(10) Trim the cores of coils L3 and L4 to obtain the proper slope on the top of the pulse.

(11) If necessary, retrim L2, L5 and L6 for best overall fidelity of the pulse shape as observed in (4) above.

(12) Tighten all core locknuts. Recheck the pulse shape to be sure that tightening has not changed fidelity.

3 SETTING THE CAL VOLTS DIAL.

CAUTION

The CAL VOLTS dial is calibrated in peak to peak volts. To convert to rms voltages divide by 2.83. The calibration voltage generator is a multivibrator operating at a frequency of approximately 5 KC. One output of the multivibrator is delivered to a front panel connector TEST VOLTS OUTPUT (J3) and another output to the CAL switch (S2).

Before any electrical adjustments are made in the calibration voltage generator circuit, the CAL VOLTS dial must be properly positioned on the shaft of the CAL VOLTS control R79. In the event it does not meet the requirement in 3 d below or it has been previously removed, proceed as follows:

a Set shaft of R79 maximum clockwise.

b Place dial on shaft so that the 1 marking is approximately one half inch to the right of the index line.

c Tighten one set screw with an allen wrench so that it is snug but not tight.

d Rotate CAL VOLTS dial maximum counterclockwise and check position of the .1 marking. The overshoot past the index line should be approximately equal to the overshoot at the 1 marking. If they are not equal loosen set screw and adjust the dial until they meet this condition.

e Tighten set screws firmly.

4 ADJUSTING THE CALIBRATION VOLTAGE GENERATOR OUTPUT.

Equipment Required:
Sine Wave Audio Frequency Signal Generator per SECTION 7 Par. 2a(4).

To adjust the output of the calibration voltage generator, it is necessary to calibrate the vertical channel. This is done as follows:

a Connect the output of a metered audio signal generator to the V INPUT connector (J1) of the oscilloscope. Set the controls of the audio signal generator as follows:

Frequency	1 KC
Output	0.363 volts rms (= 1V P-P)

b Set the Oscilloscope controls as follows:

HEATER-OFF-POWER	POWER
V MULTIPLIER	1
V GAIN	to provide an image amplitude of exactly ½ inch
CAL VOLTS dial	1

With the CAL switch in LOCK ON position, adjust R78 for a calibration image of one half inch. Reset CAL switch to OFF.

c Reset the audio signal generator as follows:

Frequency	1 KC
Output	0.036 volts rms (= 0.1V P-P)

d Reset the oscilloscope controls as follows:

V MULTIPLIER	1
V GAIN	to provide an image amplitude of exactly ½ inch
CAL VOLTS dial	.1

With the CAL switch in LOCK ON position, adjust R80 for a calibrating voltage image of one half inch. Reset CAL switch to OFF.

e It may be necessary to repeat operations *a*, *b*, *c*, and *d* again to have both ends of the CAL VOLTS potentiometer meet the required accuracy. If it is not possible to obtain this result, check the values of R78, R79, R80 and fixed resistor R77.

CAUTION

Always read the image amplitude with the minimum beam intensity commensurate with readability. Always read the amplitude from the center of the beam width at the signal peaks, not the outermost limits.

f The voltage at the TEST VOLTS OUTPUT (J-3) can be checked by patching from TEST VOLTS OUTPUT to the V INPUT connector (J1). By means of V MULTIPLIER, V GAIN and CAL VOLTS circuits, its amplitude can be measured as previously described in SECTION 4 Par. 9. The voltage amplitude of the output should be 20V ±20% peak to peak. If this value is not available at the TEST VOLTS JACK but the test for adjusting CAL VOLTS under *a*, *b*, *c*, *d* can be met, check the values of C28, R68 and R69.

b. MARKER GENERATOR ADJUSTMENT.

Equipment Required:

Sine Wave Audio Frequency Signal Generator per SECTION 7 Par. 2*a*(4).

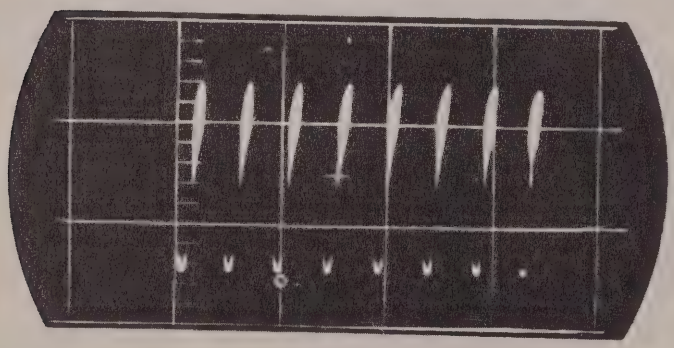
RF Signal Generator AN/URM-25 per SECTION 7 Par. 2*a*(5).

Oscilloscope AN/USM-24C per SECTION 7 Par. 2*a*(1).

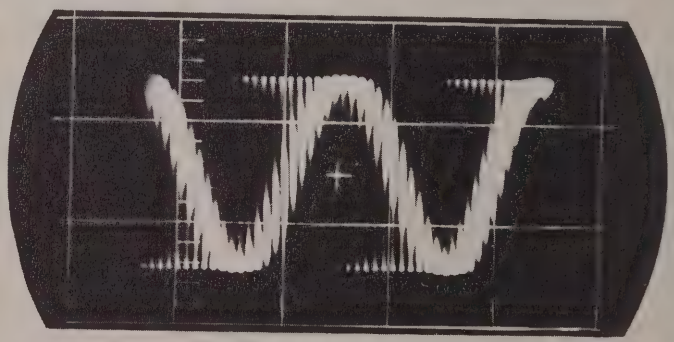
The step by step procedure for calibrating the Marker Generator is given in this paragraph. It involves two signals of approximately the same frequency. The external signal generator is connected to the vertical input of the OS-51/USM-24C under test and the signal appears as vertical deflection, and the voltage pulses generated by the marker generator appear as intensified portions of the trace. The exact position of the intensified portions of the trace depends upon the frequency and phase relations of the two voltages.

If approximately 100 cycles of the external signal are displayed any great difference in the two frequencies will appear as shown in figure 7—2*b*. As the difference decreases, fewer and fewer intensified cycles appear, until the two frequencies are equal. When this occurs, the intensification appears as a straight line figure 7—2*c*. The Marker Generator adjustment procedure is given below:

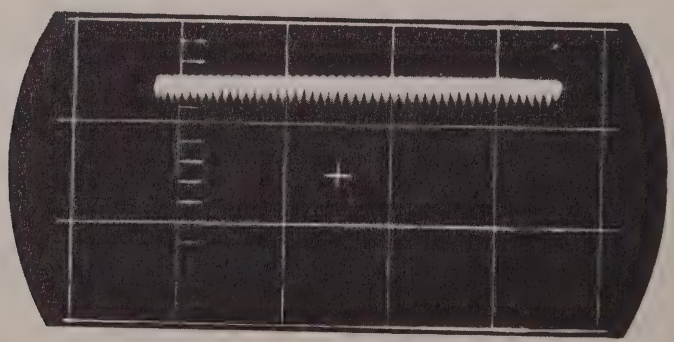
After tubes or components have been replaced in the Marker Generator circuits and if the frequency differences are small, step (1) complete and step (2)(e) listed below should be omitted. When any of the gating tubes or components have been replaced or frequency differences are large, it is important that



a



b



c

Figure 7—2. Cathode Ray Tube Patterns for Adjusting Marker Generator

the entire procedure be followed in the order given.

(1) .2 μs MARKER ADJUSTMENT.

(*a*) Set Keying Gate Adjustment (R130) to 3/4 maximum clockwise position.

Set Trimmer Capacitor, C64, to 3/4 max. cap. (do not change if previously undisturbed).

All other preliminary settings are to be at 1/2 rotation.

(*b*) Set SWEEP RANGE on .5-5 range.
Set TRIGGER PPS switch on 5000 pps.
Set SWEEP STABILITY to PULSE TRIGGER position.
Set SYNC switch on INT TRIG.
Adjust SYNC control until sweep appears.
Set MARKER μS switch on .2μs.
Adjust FINE SWEEP control to see approx. 12 markers.

(*c*) Adjust the DC LEVEL adjustment (R135) to where the first marker appears brightest.

(*d*) Apply a .2μs (5 megacycles) signal from the RF Signal Generator to V INPUT and set
TRIGGER PPS to OFF.
SYNC switch to INT SIGNAL.
MARKER μS to .2.
Adjust the sweep stability for repetitive operation.

(*e*) Adjust the FINE SWEEP so that approx. 10 cycles appear on the screen of the cathode ray tube with BEAM intensity increased.

(*f*) Set SWEEP RANGE to 5-50 range.

(*g*) Adjust the core in coil L10 to where one marker per cycle appears (this will appear as a straight horizontal line and marker elongated in the vertical plane with the BEAM intensity decreased). *NOTE:* In the event that MARKER GENERATOR tube, V21, or coil, L10, have not been replaced, the core of L10 can be left at its previous setting and this adjustment performed by adjusting trimmer capacitor, C64.

(*h*) Connect an observation oscilloscope such as an AN/USM-24C to the B+ side of coil L12.

(*i*) Adjust the core of L12 for minimum output on the screen of the observation oscilloscope.

(*j*) Remove observation oscilloscope.

(2) 1μs MARKER ADJUSTMENT (and KEYING GATE Adjustment).

(*a*) Apply a 1μs (1 megacycle) signal from the RF Signal Generator to the V INPUT and set MARKER μS switch to 1.

(*b*) Set SWEEP range to 5 to 50 RANGE, then adjust the FINE SWEEP so that approx. 10 cycles appear on the screen of the cathode ray tube with BEAM intensity increased.

(*c*) Set SWEEP RANGE to 50-500 range.

(*d*) Adjust trimmer capacitor (C65) to where one marker per cycle appears (this will appear as a straight line of intensified dots superimposed on the signal with BEAM intensity decreased). The straighter this line is adjusted the closer the marker frequency will match the applied signal frequency.

(*e*) 1. Return SWEEP RANGE to the 5-50 range and turn FINE SWEEP fully counterclockwise.

2. Turn Keying Gate adjustment (R130) counterclockwise to a point where the marker pulse appears on retrace (with BEAM intensity maximum).

3. Turn the Keying Gate adjustment clockwise, only to the position where the markers disappear from the retrace line, except at the end of the trace.

The KEYING GATE is now adjusted. Return BEAM intensity to normal.

(3) 10μs ADJUSTMENT.

(*a*) Apply a 10μs (100 kilocycle) signal from the RF Signal Generator to the V INPUT and set MARKER μS switch to 10 and SWEEP RANGE to 50-500 range.

(*b*) Adjust FINE SWEEP so that approx. 10 cycles appear on the screen of the cathode ray tube.

(*c*) Set SWEEP RANGE to 500-5K range.

(*d*) Adjust 10μs potentiometer (R209) to where one marker per cycle appears as a straight line of intensified dots superimposed on the applied signal.

(4) 100μs ADJUSTMENT.

(*a*) Apply a 100μs (10 kilocycle) signal from the Sine Wave Audio Frequency Signal Generator to the V INPUT and set MARKER μS switch to 10 and SWEEP RANGE to 50-500 range.

(*b*) Adjust FINE SWEEP so that approximately 10 cycles appear on the screen of the cathode ray tube.

(*c*) Set SWEEP RANGE to 500-5K range.

(*d*) Adjust 100μs potentiometer (R142) to where one marker per cycle appears as a straight line of intensified dots superimposed on the applied signal.

(5) 500μs ADJUSTMENT.

(*a*) Apply a 500μs (2 kilocycle) signal from the Sine Wave Audio Frequency Signal Generator to the V INPUT and set MARKER μS switch to 500 and SWEEP RANGE to 500-5K range.

(*b*) Adjust FINE SWEEP so that approximately 10 cycles appear on the screen of the cathode ray tube (with BEAM intensity increased).

(*c*) Set SWEEP RANGE switch to 5K-50K range.

(*d*) Adjust the 500μs potentiometer (R141) to where one marker per cycle appears (this will appear as a straight line of intensified dots superimposed on the applied signal).

(6) Recheck and trim adjustments if desired to exactly agree with the frequency standards being used. Each marker frequency (time) can be adjusted to as precise an accuracy as desired and will retain this accuracy over long periods of use.

c. SYNCHRONIZATION CHANNEL.

Equipment Required:
Square wave generator TS-583/U per SECTION 7 Par. 2*a*(6).

The synchronization channel is designed to produce a negative going pulse at the plate of the parallel

trigger tube regardless of input voltage polarity. It is adjusted as follows:

(1) Apply a 10KC square wave of 1.8V rms to the SYNC INPUT connector (J5). Set SYNC switch (S10) to EXT H1.

(2) Connect a lead from pin 6 of V14 to the V INPUT Jack (J1).

(3) Set V MULTIPLIER (S1) and V GAIN (R25) for approximately one inch of vertical deflection.

(4) Rotate the SYNC control (R106) clockwise.

(5) With SWEEP RANGE switch set to 50-500 range, adjust the FINE SWEEP control (R120A/B) for three cycles display.

(6) Adjust trimmer C47 until the leading edge of the square wave is slightly over-peaked (figure 7—1). If C47 does not produce this over-peak condition, check capacitor C47 and resistors R99 and R100.

(7) Rotate the SYNC control through its entire range and note the null point. If the knob index does not point to "O," remove the knob with a No. 4 Allen wrench and set the SYNC control on its null point. Replace the knob in a vertical position so that the index line is at "O," and tighten the set screw.

(8) Reduce the square wave to 0.18 volts rms. Set the SYNC switch to EXT LOW. With the V MULTIPLIER and V GAIN controls set for approximately one inch of deflection, rotate the SYNC control in both directions from "O." If the sweep does not go into synchronization in both directions, check V14.

(9) Remove the lead from pin 6 of V14 to the V INPUT Jack.

d. LINEAR TIME BASE.

Equipment Required:

Oscilloscope AN/USM-24C per SECTION 7 Par. 2*a*(1).

Potentiometer, 500 ohms, per SECTION 7 Par. 2*a*(9).

Sine Wave Audio Frequency Signal Generator per SECTION 7 Par. 2*a*(4).

(1) The enabling gate generator and the linear time base generator may be checked completely by following the steps outlined in table 7—5. The linearity of the sweep should be checked after each step in the manner described in paragraph (2). Before proceeding, it is recommended that the theory of operation of the linear time base channel be reviewed in SECTION 2, paragraph 5.

(2) SWEEP LINEARITY CHECK.

The linearity of the trace must be checked after each step of the procedure outlined in table 7—5. This is done by counting the number of markers on the center half inch of the two and a half inch trace. Then count the number of markers on any other half inch portion of the trace. The time represented by any other half inch portion of the trace must be within 10% of the center half inch. (Not applicable to .5 to 5 μs sweep range.) If the linearity is not within these limits, the following steps must be taken:

(*a*) Check the waveform and amplitude of the pulse at the grid (pin 7) of the sweep generator (V26B) against the pulse shown in figure 7—12. If incorrect, trouble shoot the enabling gate generator [see SECTION 7 Par. 3*d*(1)], check the attenuator consisting of R171, R172 and C83 and replace defective components.

(*b*) If pulse is correct (shape and amplitude) make a check of the linear sweep generator (figure 2—13) and associated components (resistors R175, R176, R177, and R120A, and capacitors C85 and C60b).

(*c*) If nonlinearity is apparent on only one sweep range, check the components used for that particular range as listed in table 7—5. Replace the defective component.

(3) EXPANDED SWEEP DELAY.

The sweep delay circuit in conjunction with the horizontal input circuits is capable of amplifying ten times any selected 10% portion of the output of the linear sweep generator. The SWEEP DELAY control (R187) is used to select the portion of the sweep to be amplified when the SWEEP DELAY switch (S15) is set to the "IN" position. The Sweep Delay Range potentiometer (R186) determines the total range of operation and is adjusted as follows:

(*a*) Set up the OS-51/USM-24 as outlined in table 7—5.

(*b*) Rotate the SWEEP DELAY control fully clockwise.

(*c*) Adjust R186 until the last portion or end of the expanded trace is on the screen of the cathode ray tube.

(*d*) If adjustment will not operate properly, check items 17 and 18 in table 7—2.

(4) PULSE TRIGGER ADJUSTMENT.

(*a*) GENERAL. The fixed "PULSE TRIGGER" position on the SWEEP STABILITY control is used whenever standard trigger pulses (5 to 150V amplitude) are available for triggering the sweep. When the SWEEP STABILITY control is in the "PULSE TRIGGER" position, rotating the SYNC control (R106) towards + will trigger the sweep with the leading edge of positive pulses, and rotating the SYNC control towards — will trigger the sweep with the leading edge of negative pulses. The PULSE TRIGGER ADJ. (R127) circuit is electrically the same as the SWEEP STABILITY control circuit and performs the same functions except that it is preset for an amplitude of 5 volts peak or greater. The PULSE TRIGGER ADJ. is adjusted at the factory with positive and negative pulses of 5 volts peak amplitude. For normal usage this setting is quite satisfactory and should require no readjustment. However, for special application of prolonged operation, greater or lesser sensitivities may be desired in the fixed "PULSE TRIGGER" setting. This may be acquired by using the same adjustment procedure described below but substituting the available pulse amplitude in place of the 5V amplitude. For normal readjustment of the

TABLE 7—5. LINEAR SWEEP GENERATOR TEST

Note: The Marker Generator must be operating accurately, as described in Paragraph 3*b*, before starting this test.

STEP NO.	CONTROL SETTINGS							RANGE OF MARKERS ON TRACE TO BE OBSERVED	POSSIBLE CAUSE IF DESIRED NUMBER OF MARKERS IS NOT OBTAINED
	V INPUT	V MULTIPLIER AND V GAIN	SWEEP RANGE	SYNC SWITCH	FINE SWEEP	MARKER μS SWITCH	TRIGGER PPS		
1	NONE	MAXIMUM ATTENUATION	.5-5	INT TRIGGER	CCW	.2	5000	6 to 8	C54 (misadjusted) C55, C87, R119, R175, V16, V17
2	NONE	MAXIMUM ATTENUATION	.5-5	INT TRIGGER	CW	1	5000	9 to 16	Fine Sweep R120 A/B
3	NONE	MAXIMUM ATTENUATION	5-50	INT TRIGGER	CCW	1	5000	11 to 14	C56 or C88
4	NONE	MAXIMUM ATTENUATION	5-50	INT TRIGGER	CW	10	800	9 to 16	C56 or C88
5	NONE	MAXIMUM ATTENUATION	50-500	INT TRIGGER	CCW	10	800	11 to 14	C57 or C89
6	NONE	MAXIMUM ATTENUATION	50-500	INT TRIGGER	CW	100	300	9 to 16	C57 or C89
7	NONE	MAXIMUM ATTENUATION	500-5K	INT TRIGGER	CCW	100	300	11 to 14	C58 or C90
8	NONE	MAXIMUM ATTENUATION	500-5K	INT TRIGGER	CW	500	50	19 to 31	C58 or C90
9	NONE	MAXIMUM ATTENUATION	5K-50K	INT TRIGGER	CCW	500	50	22 to 28	C59 or C91
10	100 CPS	1 INCH DEFLECTION	5K-50K	INT SIGNAL	CW	BEAM MOD	OFF	9 to 16 cycles	C59 or C91

GENERAL CONDITIONS

CONTROLS	SETTING
H GAIN	Adjust for approximately 2 inches.
SWEEP STABILITY	PULSE TRIGGER position for Steps 1 to 9 inclusive. Repetitive for Step 10.
SYNC	In "+" direction. AVOID OVER SYNCHRONIZATION.

fixed PULSE TRIGGER ADJ. control, the procedure is as follows:

(*b*) ADJUSTMENT PROCEDURE.

1. Set CAL VOLTS dial (R79) at 0.5.

2. Set CAL switch (S2) to LOCK ON.

3. Adjust the V GAIN control (R25) for one inch deflection of calibration voltage. Return the CAL switch to OFF. Do not change the V GAIN setting during the balance of the procedure.

4. Set V MULTIPLIER (S1) to 10.

5. Connect a 500 ohm potentiometer with its 2 outer terminals across the positive TRIGGER OUTPUT connector (J8), so that clockwise rotation of the potentiometer shaft increases the resistance of the center arm to ground.

6. Set TRIGGER PPS switch (S14) to 800.

7. Connect a wire lead from the center arm of the 500 ohm potentiometer to the V INPUT connector and adjust the potentiometer to obtain one inch deflection. This sets the output from the 500 ohm potentiometer at 5 volts peak and the potentiometer must not be changed throughout the balance of the adjustment.

8. Remove the wire lead from the V INPUT connector and reconnect it to the SYNC INPUT connector (J5). Set the SYNC selector switch (S10) to EXT. LOW.

9. Set SWEEP RANGE (S11) to the 50-500 position, and set FINE SWEEP (R120A/B) maximum clockwise.

10. Set SYNC control (R106) to "0." Sweep should not appear. Advance the SYNC control in the

+ direction. Sweep should appear. Return SYNC control to "0" and sweep should disappear. If these conditions do not exist, adjust the PULSE TRIGGER ADJ. until sweep appears, then set the SYNC control to "0" and adjust the PULSE TRIGGER ADJ. counterclockwise, until the sweep just disappears.

11. Repeat the check reconnecting the potentiometer across the — TRIGGER OUTPUT connector (J7) and advancing the SYNC control in the — direction. A very slight retrimming of the PULSE TRIGGER ADJ. may be required.

e. TRIGGER GENERATOR.

(1) The trigger generator consists of a blocking tube oscillator. The repetition rate is determined by the RC time constants in the grid circuit and by the voltages applied to them.

(2) The three important characteristics of the trigger pulse are its waveform, frequency and amplitude. The sine wave generator is the only additional piece of equipment needed for checking and adjusting these characteristics. When the trigger pulse is impressed across the vertical plates of a cathode ray tube, and a known frequency is impressed across the horizontal deflecting plates, the resultant Lissajous pattern permits a rapid frequency check. One trigger pulse will stand still whenever its frequency (repetition rate) is equal to, or a sub-harmonic of the signal frequency on the horizontal plates. To determine if the trigger pulse frequency is equal to the fundamental of the audio generator or its sub-harmonic, reset the audio generator, to one-half its original frequency. If two vertical pulses appear the trigger pulse frequency is equal to the original frequency. The procedure for making this test is as follows:

(*a*) Connect the sine wave generator to the H INPUT (J10) connector.

(*b*) Set the SWEEP RANGE switch (S11) to the H AMP position and adjust the output of the audio generator and the H GAIN control for a trace of approximately 2 inches.

(*c*) Connect an RF cable CG-409/U(8'0") between the V INPUT connector (J1) and the + TRIGGER OUTPUT connector (J8).

(*d*) Set the V MULTIPLIER (S1) at position 300 and adjust the V GAIN (R25) for approximately one-half inch deflection.

(*e*) Starting with the TRIGGER PPS switch (S14) in the 800 position, set the audio generator at 800 cps, and adjust the Trigger Rate Adjustment (R168) until one pulse appears and its rotating motion stops (figure 7—3). To check this setting, reset the audio generator to 400 cps and two pulses should appear.

(*f*) Set the TRIGGER PPS switch to the 2000 position. Vary the audio generator frequency dial around 2000 cps and note down the exact frequency at which one pulse appears. Check this frequency by resetting the audio generator to one-half the noted frequency to observe two pulses.

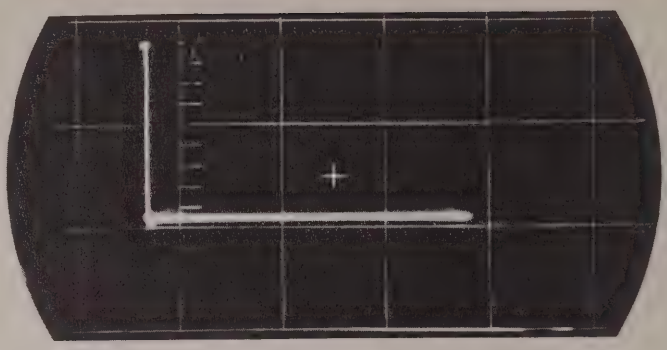


Figure 7—3. Comparison of Trigger Rate and Oscillator Frequency

(*g*) Repeat this check for each position of the TRIGGER PPS switch as indicated below. It may be necessary to trim the Trigger Rate Adjustment to bring a given range into tolerance. If this is done, recheck all other ranges to be sure that they are within the limits shown below.

TABLE 7—6. TRIGGER RATE ADJUSTMENT

STEP	TRIGGER PPS	NUMBER OF PULSES	AUDIO SIGNAL GENERATOR FREQUENCY
1.	5000	1	4750 to 5250
2.	5000	2	2375 to 2625
3.	2000	1	1900 to 2100
4.	2000	2	950 to 1050
5.	800	1	760 to 840
6.	800	2	380 to 420
7.	300	1	285 to 315
8.	300	2	142.5 to 157.5
9.	50	1	47.5 to 52.5
10.	50	2	23.75 to 26.25

(3) The amplitude can be measured by setting the CAL switch (S2) to either HOLD ON or LOCK ON position, setting the V MULTIPLIER (S1) to 100 and adjusting the CAL VOLTS dial (R79) until the amplitude of the calibration voltage is equal to the pulse amplitude. The CAL VOLTS dial should read between 0.25 and 0.5. These are the equivalent of 25 to 50 volts peak to peak.

(4) The waveform of the trigger pulse may be observed as follows:

(*a*) Patch from the + TRIGGER OUTPUT connector (J8) to the V INPUT connector (J1) as described above.

(*b*) Set controls as follows:

Control	*Setting*
SWEEP RANGE	.5-5
SYNC	INT TRIG
MARKER μS	0.2
TRIGGER PPS	5000
FINE SWEEP	Sweep time of 3 or 4 microseconds
H GAIN	2 inch trace
V MULTIPLIER	300
V GAIN	¾ inch image height

(*c*) The pulse duration, amplitude and rise time should be as shown in figure 7—4. If the pulse shows any abnormality it can usually be traced to a defective trigger generator (V23) or pulse transformer (T2).

f. DISPLAY CHANNEL.

Equipment Required:

Non-electric multimeter per SECTION 7 Par. 2*a*(2).

(1) GENERAL. The basic operating principles and the physical construction of the cathode ray tube are discussed in SECTION 2, paragraph 2. Certain points concerning cathode ray tubes should be stressed.

(*a*) High voltages are always present around cathode ray tubes and care must be exercised.

(*b*) Always protect your hands and face when handling or replacing a cathode ray tube since this type of tube has a tendency to implode if shocked suddenly.

(*c*) Never leave a spot of high intensity on the cathode ray tube screen. Irreparable damage may be done to the fluorescent material.

(2) ASTIGMATISM ADJUSTMENT. The average voltage of the deflection plates and the second anode voltage must be maintained equal so that there will be no defocusing of the beam as it is deflected across the screen. As only the average voltage on the vertical deflection plates and the second anode are adjustable, it is necessary to use the average voltage on the horizontal deflection plates as a reference. The following procedure should be used to adjust the 2nd Anode voltage control (R66) and the Astigmatism control (R50).

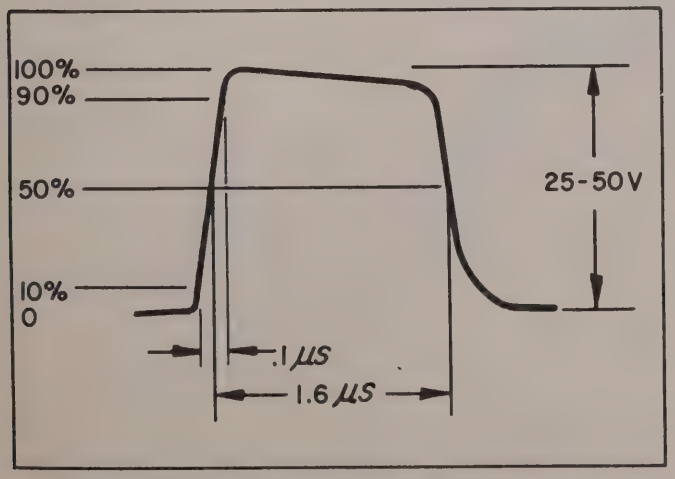


Figure 7—4. Trigger Generator Output Pulse

(*a*) Set the controls as follows:

SWEEP RANGE	H AMP
V POS	Center the spot vertically
H POS	Center the spot horizontally

(*b*) Measure the voltage at terminals 1 and 2 of TB7 (the voltage at both terminals should be approximately equal). Set the Astigmatism adjustment so that the average of the voltages at terminals K and M of TB9 are equal to the average of the voltages at terminals 1 and 2 of TB7. Adjust the 2nd Anode Adj. until the voltage at terminal D of TB11 is equal to the average of the voltages at terminals 1 and 2 of TB7.

(*c*) It may be necessary to retrim the Astigmatism Adjustment and the 2nd Anode adj. slightly to obtain the best focusing over the entire screen.

g. TEST LEAD CG-883A/USM-24.

Equipment Required:

Square Wave Generator TS-583/U per SECTION 7 Par. 2*a*(6).

(1) GENERAL. Test Lead CG-883A/USM-24 provides an attenuation of 10:1. The test lead, in conjunction with the V MULTIPLIER, forms a voltage divider network, and thus requires compensation to provide equal attenuation at all frequencies. The test lead forms the series arm of the divider, and the input resistance and capacitance form the shunt arm. Capacitor C301 in the test lead is variable so that it can be adjusted to provide the proper capacitance ratios between the test lead and the oscilloscope.

(2) CAPACITY ADJUSTMENT. Paragraph 3*a*(1) describes the procedure for checking and adjusting the variable capacitors of the V MULTIPLIER. The test should be made before any adjustments are made to C301. The procedure for adjusting C301 is as follows:

(*a*) Connect a square wave generator to the V INPUT (J1). Set the output of the square wave generator to 10KC and adjust the output voltage to 0.5V.

(*b*) Connect a fixed voltage output of the square wave generator to the SYNC INPUT connector (J5).

(*c*) Set the oscilloscope controls as follows:

V MULTIPLIER	10
V GAIN	To provide a usable image
SYNC	EXT HI
SWEEP RANGE	50-500
FINE SWEEP	Three cycles of the square wave

(*d*) Disconnect the square wave generator from the V INPUT and connect CG-883A/USM-24 to the V INPUT connector. Change the V MULTIPLIER set-

ting to 1 and connect the square wave generator to test lead CG-883A/USM-24 as shown in figure 7—5. Adjust C301 so that the image appears as shown in figure 7—1.

b. TEST LEAD CG-1277/USM-24C.

Equipment Required:

Square Wave Generator TS-583/U per SECTION 7 Par. 2*a*(6).

(1) GENERAL. Test Lead CG-1277/USM-24C is a low capacity probe of the cathode follower type. The theory of its operation is discussed in SECTION 2. The test lead is primarily intended for measurement of signal voltages of low amplitudes (up to 2 volts peak to peak) in circuits where capacitive loading would give false readings. Further requirements are that the probe must have good high frequency response and less than 40% attenuation.

(2) ATTENUATION TEST. Using the CAL Volts, calibrate the vertical channel so that 0.2 volts peak to peak produces one inch of deflection. Set the V MULTIPLIER at 10 and apply a 10KC square wave to the V INPUT. Adjust the output of the square wave generator only for one inch deflection. Remove the generator from the V INPUT without disturbing its output controls or the previous setting of the V GAIN control. Connect Test Lead CG-1277/USM-24C to the V INPUT and PROBE POWER connectors. Apply the output of the square wave generator to the test lead. The total deflection must not be less than 0.6 inches. If it is less, check the B voltage and the filament voltage at the PROBE POWER connector. If these voltages are found to be normal, tube V301 may be defective.

(3) FREQUENCY RESPONSE TEST. Apply a 10KC square wave through the test lead. Set the V MULTIPLIER switch at 1 and adjust the V GAIN control for one inch of deflection. The top and bottom portion of the square wave should not have a tilt greater than one half division. If there is a tilt greater than this, check the components in the probe. If these check satisfactorily, replace the electron tube V301.

4. DISASSEMBLY PROCEDURES.

a. COMBINATION CASE. To remove the combination case from the oscilloscope proceed as follows:

(1) Lay the oscilloscope carefully on its face.

(2) Remove the four rubber legs from the bottom of the combination case by removing the No. 12-24 screws which hold them.

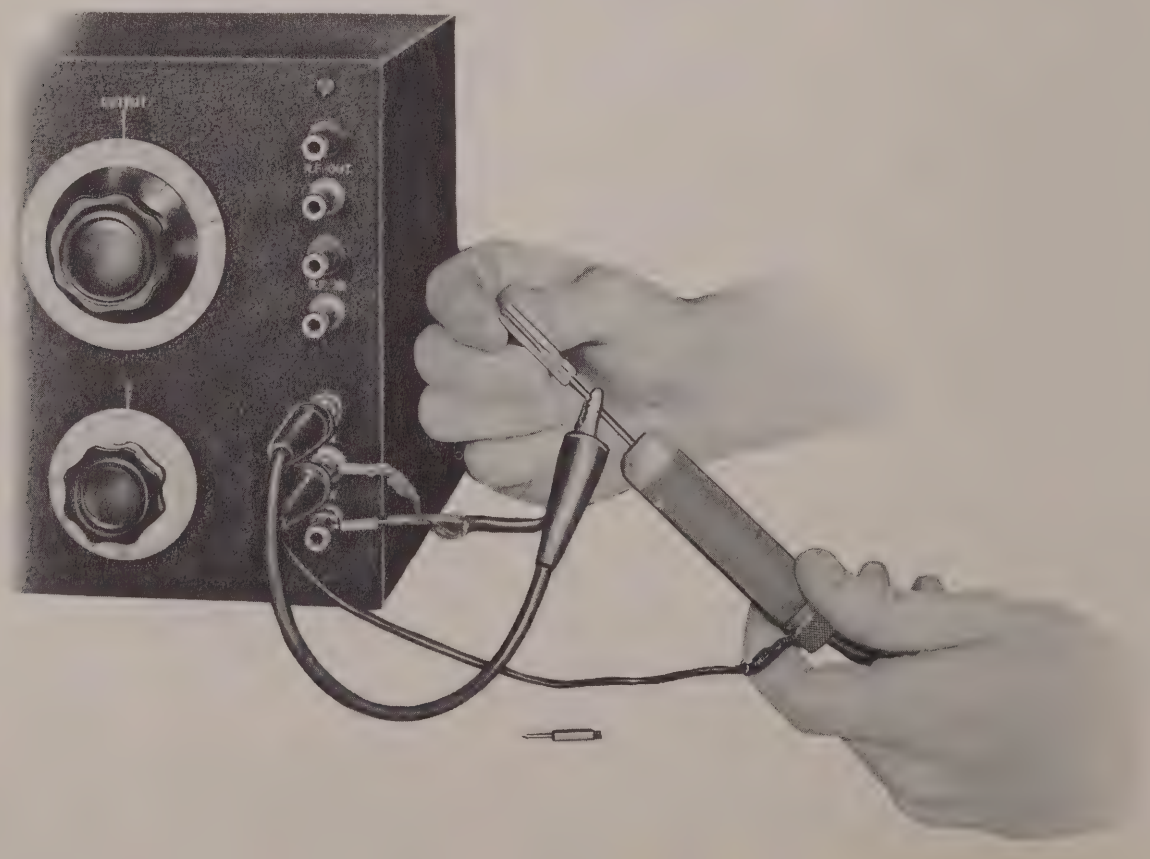


Figure 7—5. Connecting Test Lead CG-883A/USM-24 to Square Wave Generator for Compensation

(3) Remove the total of six No. 12-24 screws on the top and each side of the combination case (see figure 4—1).

(4) Slide the combination case upwards.

b. UPPER LEFT HAND CHASSIS.

(1) Use the Allen wrenches located in the combination case cover (CW-362/USM-24C) and remove the knob from the CAL switch (S2) and the CAL VOLTS dial.

(2) Remove the hex nuts which mount these controls to the front panel.

(3) Remove the screw where the diagonal support bar is attached to the chassis (see figure 7—23).

(4) Unsolder the two wires at the V GAIN control (R25) (see figure 7—29).

(5) From the V MULTIPLIER switch assembly (S1), unsolder the wire which runs through the chassis to the CAL switch (S2).

(6) Unsolder the wire from terminal "C" of the PROBE POWER connector (J-2) (see figure 7—29).

(7) Unsolder the wire from the cable to the CAL VOLTS control (R79) (see figure 7—23).

(8) Remove the cable from the two cable clamps on the angle frame (see figure 7—21).

(9) Remove all "disconnect terminals" from TB9 (see figure 7—23).

(10) Remove the five screws holding the X frame support bar assembly to the chassis (see figure 7—21).

(11) Remove the three "disconnect terminals" from TB2 (see figure 7—21).

(12) Remove the cathode ray tube cable from the clamp attached to TB2 (see figure 7—21).

(13) Remove the two upper screws holding the BLOWER assembly B1 to the frame (see figure 7—21).

(14) Remove the screw and support bar from the DELAY LINE assembly DL1 (see figure 7—20).

(15) Remove the screw holding the chassis to the U bracket which is suspended from the rear upper angle frame (see figure 7—21).

(16) Remove the 2 screws holding the support bracket to the angle frame.

(17) Drop the rear end of the chassis and remove it from the rear.

(18) If necessary for clearance, loosen or remove the two screws holding TB2 to the chassis (see figure 7—25).

c. UPPER RIGHT HAND CHASSIS.

(1) Remove the knobs from the following controls:

(*a*) H POS (R196).
(*b*) SWEEP DELAY (S15).
(*c*) FINE SWEEP (R120A/B).
(*d*) SYNC (R106).
(*e*) SWEEP DELAY (R187).
(*f*) H GAIN (R193).
(*g*) SWEEP STABILITY (R126).

(2) Remove the hex nuts which mount these controls to the front panel.

(3) Unsolder the black wire which runs from the H POS control (R196) to the upper dial lamp assembly (XDS4) (see figure 7—20).

(4) Unsolder the wire from the SYNC switch (S10) which goes to C49 on TB5.

(5) Unsolder the wire from the SWEEP OUTPUT connector (J9) (see figure 7—21).

(6) Unsolder the wire which goes from R170 on TB7 to TB1.

(7) Unsolder the wire which goes from R128 on TB7 to the lower chassis.

(8) Remove all "disconnect terminals" from TB8 (see figure 7—24).

(9) Remove cable from the clamp attached to the angle frame.

(10) Remove both "disconnect terminals" from TB7 (see figure 7—21).

(11) Remove the five screws holding the X frame support bar to the chassis (see figure 7—21).

(12) Remove V20 shield and tube from the lower chassis (see figure 7—27).

(13) Remove the screw where the diagonal support bar is attached to the chassis (see figure 7—24).

(14) Remove the screw holding the chassis to the U bracket which is suspended from the rear upper angle frame (see figure 7—21).

(15) Lift the chassis from the frame.

d. DELAY LINE (DL1).

(1) Unsolder the two wire leads at the delay line.

(2) Remove the screw and support bar from the top of the delay line (see figure 7—20).

(3) Remove the two screws holding the bottom mounting plate to the chassis (see figure 7—20).

(4) Remove the delay line.

e. BLOWER MOTOR ASSEMBLY (B1) (Complete disassembly).

(1) Unsolder the black wire from the ground lug (see figure 7—6).

(2) Unsolder the other wire from the motor assembly.

(3) Remove the four screws holding the shock mounted mounting plate to the angle frame and chassis (see figure 7-21).

(4) Remove the complete blower motor assembly.

(5) Remove the four screws holding the fan housing and screen to the mounting angle bracket.

(6) Loosen the two set screws on the fan through the hole in the blower housing and remove the fan from the motor shaft (see figure 7—6).

(7) Remove three screws holding the motor assembly and carefully remove the motor from the housing (see figure 7—6).

(8) If necessary unsolder both leads of the capacitor from the motor terminals (see figure 7—6). Figure 7—6 is an exploded view of the BLOWER MOTOR ASSEMBLY, and should facilitate the disassembly of the BLOWER MOTOR ASSEMBLY.

f. CATHODE RAY TUBE ASSEMBLY. In order to replace certain components mounted on the top of the lower chassis, it is necessary to first remove the

cathode ray tube and its shield assembly. This is done as follows:

(1) Remove the cathode ray tube as described in SECTION 5.

(2) Slide off the lamp sockets (XDS-1 and XDS-2) which are mounted on two ears on the front end of the cathode ray tube shield.

(3) Remove the escutcheon, green light filter and graph screen by removing the four screws which hold them to the front panel.

(4) Remove the three screws which hold the metal retaining ring to the front panel. These screws also hold the front end of the outer cathode ray tube shield.

(5) Remove the two screws which hold the shield brackets to the U bracket at the rear of the unit (see figure 7—20).

(6) Lift out the cathode ray tube shield.

g. TEST LEAD CG-883A/USM-24. To make repairs to the attenuator probe, it is necessary to first remove the outer shell. This is done as follows:

(1) Unscrew the probe tip.

(2) Use the spanner wrench, provided in the combination case cover, to remove the special nut located in the bakelite end piece.

(3) Slide the bakelite end piece forward over the stud.

(4) Slide the shell forward exposing the components of the probe. Figure 7—8 is an exploded view of the Test Lead CG-883A/USM-24, and will greatly help the repairman in the disassembly of the probe.

h. TEST LEAD CG-1277/USM-24C. In order to repair this probe, it is first necessary to disassemble it. This is done as follows:

(1) Unscrew the tip from the probe.

(2) Unscrew the special nut located in the bakelite end piece, by use of the spanner wrench provided in the combination case cover.

(3) Slide the bakelite end piece forward over the stud.

(4) Slide the shell forward, exposing the components of the probe.

(5) To remove the cover of the cable junction box, it is necessary to remove the three screws holding the cover. These screws are staked with a holding compound, and it is necessary to first break the seals before the screws can be removed. Figure 7—9 is an exploded view of Test Lead CG-1277/USM-24C. It will be of great help to the repairman in the disassembly of the probe.

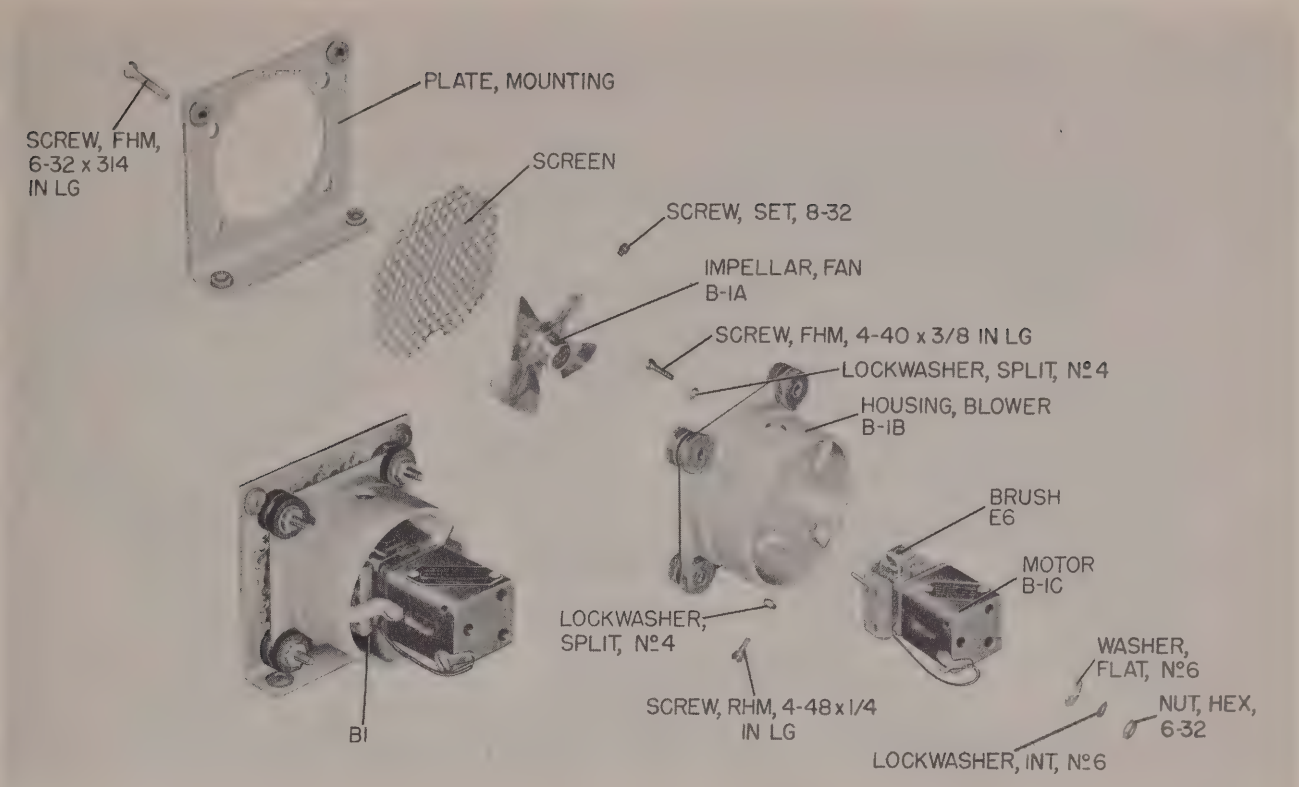


Figure 7—6. Blower Motor Assembly (B1) Exploded View

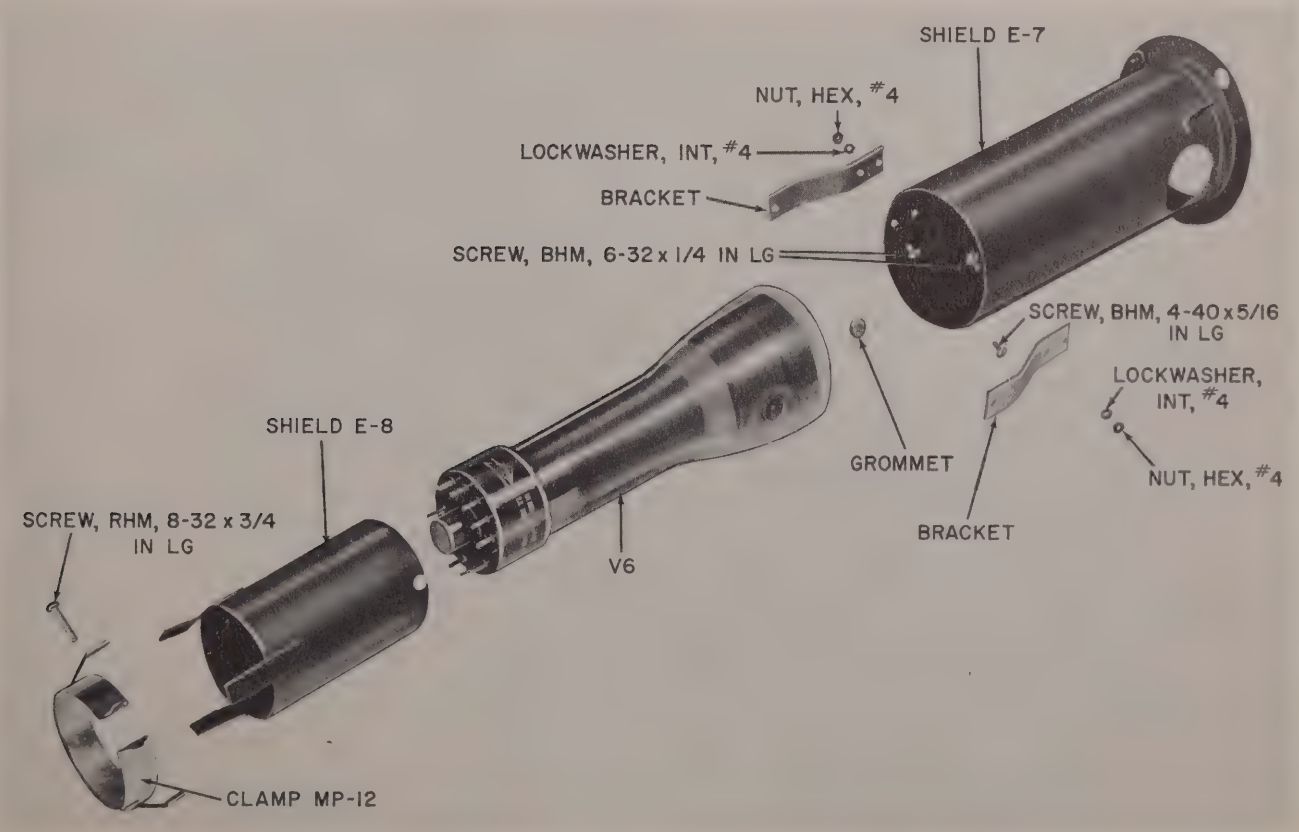
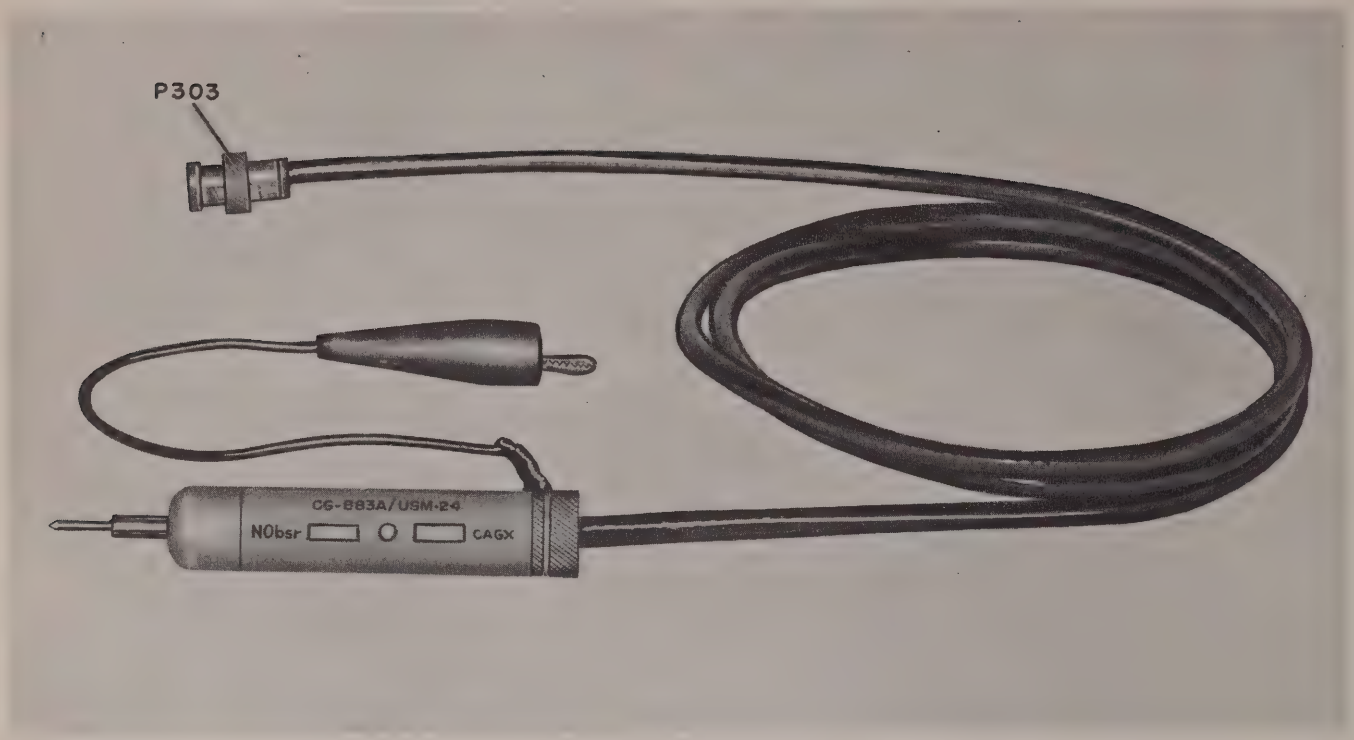


Figure 7—7. Cathode Ray Tube Shield Assembly, Exploded View



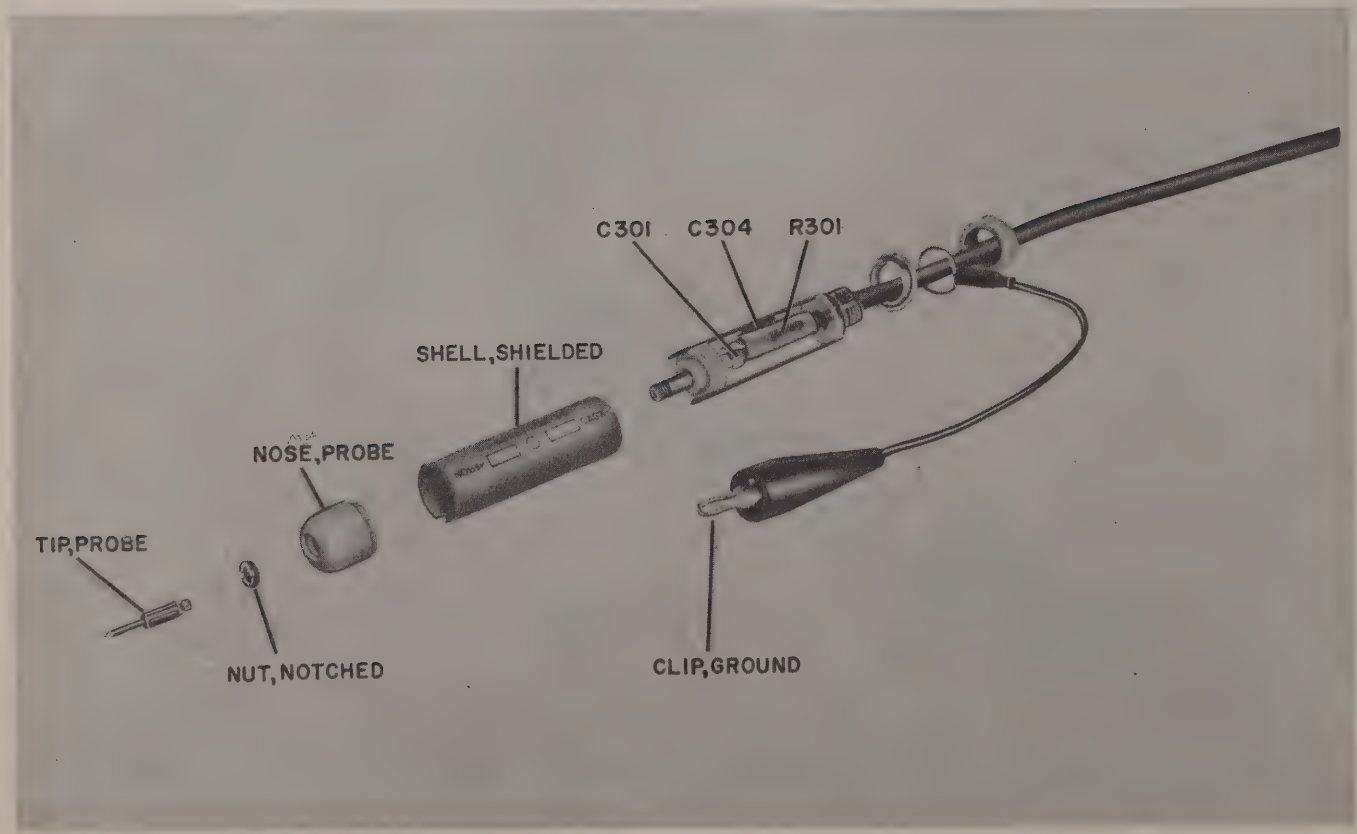


Figure 7—8. Test Lead CG-883A/USM-24

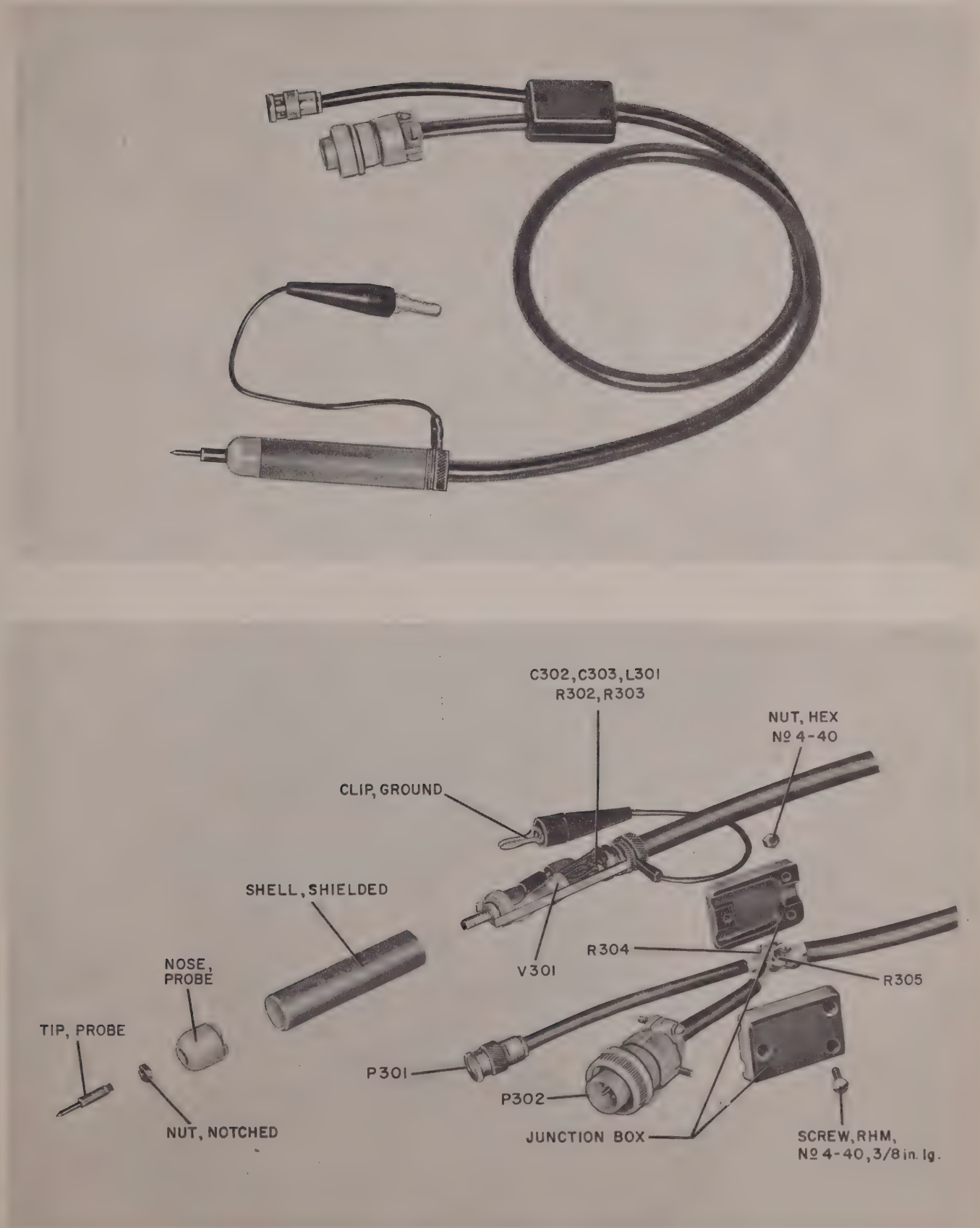
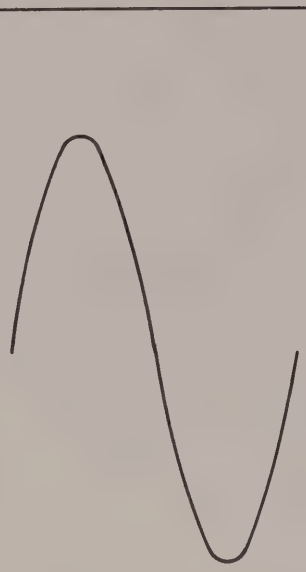
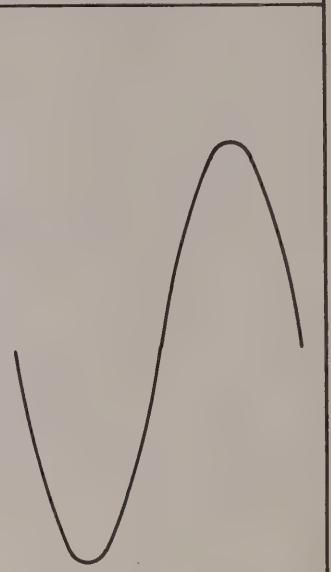
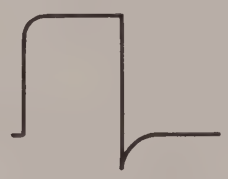
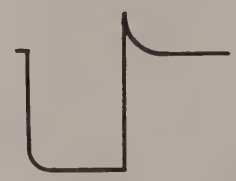


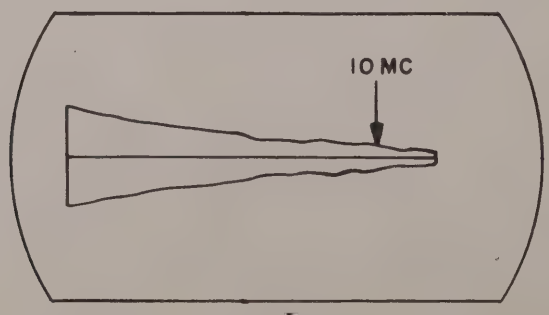
Figure 7–9. Test Lead CG-1277/USM-24C

5. NORMAL WAVEFORMS.

The normal waveforms of voltage at important test points in the oscilloscope are shown in figures 7—10 to 7—15 inclusive. These waveforms may be used as a guide in trouble shooting defective circuits. All waveforms are measured to ground, and the illustrations given here represent ideal conditions. Small departures from these waveforms are allowable, but large departures indicate that the associated circuit is defective.

TUBE	PIN	PEAK TO PEAK VOLTS	WAVE FORM	TUBE	PIN	PEAK TO PEAK VOLTS	WAVE FORM
V1	1	1.0		V1	5	6.0	
V2	1	20.0		V2	2	4.0	
V3	5	14.0			7	6.0	
V4	1	12.0			8	4.0	
V5	5	87.5		V3	1	0.7	
V7	1	66.0		V4	5	87.5	
	6			V7	2	66.0	
					7		

a



b

Figure 7—10. Waveform Guide, Vertical Channel

GENERAL CONDITIONS (Fig. 7—10a)

OSCILLOSCOPE UNDER TEST

Sine Wave Generator (AN/USM-30) 1 KC, 10V p-p applied to V INPUT.

V MULTIPLIER	1
V GAIN	Max CW
SYNC	INT SIGNAL

VIEWING OSCILLOSCOPE

Lead Test CG-883A/USM-24 used to view all waveforms.

V MULTIPLIER, V GAIN	Standard image height
SWEEP RANGE	500—5K
FINE SWEEP	Adjust for 1 cycle
SYNC	INT SIGNAL

Note: for V7, SWEEP RANGE 50—500
For figure 7—10b General Conditions see SECTION 7 Par. 3*a*(3)(*b*)2.

TUBE	PIN	PEAK TO PEAK VOLTS	WAVE FORM
V28	7	6.2	
V29	1	190.0	

TUBE	PIN	PEAK TO PEAK VOLTS	WAVE FORM
V28	6	48	
V29	2	31	
	6	190	
	3	15	
	8		

Figure 7—11. Waveform Guide, Horizontal Channel

GENERAL CONDITIONS

OSCILLOSCOPE UNDER TEST

SWEEP RANGE	50—500
FINE SWEEP	Max CW
SYNC selector	INT TRIG
SYNC control	+
TRIGGER PPS	2000
SWEEP DELAY	OUT
SWEEP STABILITY	PULSE TRIGGER
H GAIN	2½ inches

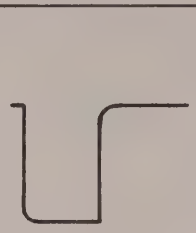
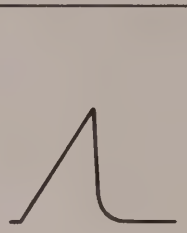
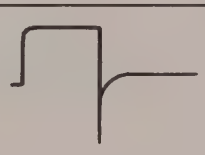
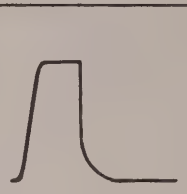
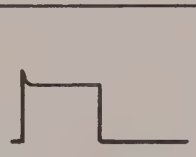
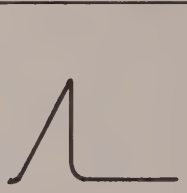
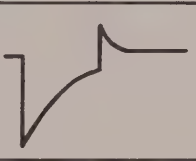
VIEWING OSCILLOSCOPE

SWEEP RANGE	50—500
FINE SWEEP	Adjust for 1 cycle
SYNC selector	EXT HI
SYNC control	+
TRIGGER PPS	OFF
SWEEP DELAY	OUT
SWEEP STABILITY	Good Trigger Action
H GAIN	2½ inches

Patch from + TRIGGER OUTPUT of test oscilloscope to SYNC INPUT of viewing oscilloscope with Cable CG-409/U (8′ 0″).

NOTE:

The conditions listed for figure 7—11 is the same for figures 7—12 and 7—13, except for those noted under the figures.

TUBE	PIN	PEAK TO PEAK VOLTS	WAVE FORM	TUBE	PIN	PEAK TO PEAK VOLTS	WAVE FORM
V16	1	63		V26	2	42	
V17	2	63			3	37	
	3	60			6	42	
V26	7	55		V27	7	37	
V16	2	57		V27	1	86	
V17	6	130					
V16	3	4.8		V27	3	18	
	8				8		
V17	7	60					

For V27, SWEEP DELAY switch IN SWEEP DELAY control Midway

For general conditions see figure 7—11.

Figure 7—12. Waveform Guide, Linear Time Base Channel

TUBE	PIN	PEAK TO PEAK VOLTS	WAVE FORM
V14	2	4	
	3	3.5	
	6	3.5*	
V15	1	60.0	

*Depends on setting of sync control.

For general conditions see figure 7—11.

FOR V15, SWEEP RANGE 500—5K

Figure 7—13. Waveform Guide, Synchronization Channel

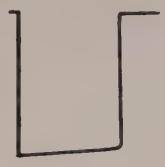
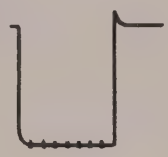
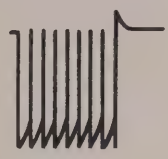
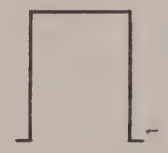
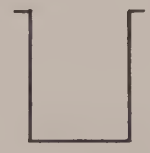
TUBE	PIN	PEAK TO PEAK VOLTS	WAVE FORM	TUBE	PIN	PEAK TO PEAK VOLTS	WAVE FORM
V18	7	36.0		V22	1	3.15	
	8	17.0			5	20.0	
V21	1	12.0		V24	1	31.0	
	7						
	8	5.5			6	5.5	

Figure 7—14. Waveform Guide, Intensity Channel

GENERAL CONDITIONS

OSCILLOSCOPE UNDER TEST	
SWEEP RANGE	5—50
MARKER μS	10
FINE SWEEP	Midway
TRIGGER PPS	5000

VIEWING OSCILLOSCOPE	
SWEEP RANGE	50—500
MARKER μS	BEAM MOD
FINE SWEEP	Adjust for 1 cycle
SYNC	EXT HI

Patch from + TRIGGER OUTPUT of test oscilloscope to SYNC INPUT of viewing oscilloscope with Cable CG-409/U (8′ 0″).

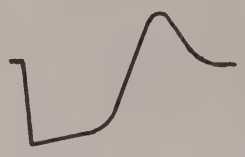
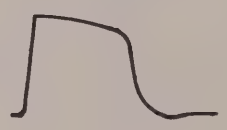
TUBE	PIN	PEAK TO PEAK VOLTS	WAVE FORM
V23	1	270	
	6		
	2	260	
	7		
	3	27	
	8		

Figure 7—15. Waveform Guide, Trigger Generator

GENERAL CONDITIONS

OSCILLOSCOPE UNDER TEST

TRIGGER PPS 5000

VIEWING OSCILLOSCOPE

SWEEP RANGE 50—500
FINE SWEEP Adjust for 1 cycle

Patch from + TRIGGER OUTPUT of test oscilloscope to SYNC INPUT of viewing oscilloscope with Cable CG-409/U (8′ 0″).

TABLE 7—7. VOLTAGE CHART FOR AN/USM-24C

TUBES	PIN NUMBERS													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
V1	0	1.6	6.3AC	0	121	162	1.6							
V2	120	0	2.1	6.3AC	6.3AC	145	26*	47						
V3	−.53*	0	6.3AC	0	110	145	0							
V4	61*	83	6.3AC	0	205	205	83							
V5	61*	83	6.3AC	0	205	205	83							
V6	−1100	−1100	−1200		−700		197*	197*	240*	142*	363*			
V7	84	−17*	0	6.3AC	6.3AC	84	−17*	0						
V8	240AC			6.3AC	0		260		240AC					
V9	240AC			6.3AC	0		260		240AC					
V10	240AC			6.3AC	0		260		240AC					
V11	240AC			6.3AC	0		260		240AC					
V12				1900	1900				270					
V13				270	270				−1500					
V14	224	7.0*	11	6.3AC	6.3AC	209	3.8*	6.3						
V15	164	0	6.3AC	0	.64*		164							
V16	164	−20	2.8	6.3AC	6.3AC	164	.64*	2.8						
V17	225	164	162	6.3AC	6.3AC	105	0	0						
V18	15	15	14	6.3AC	6.3AC	90	14*	15						
V19					150		0							
V20	150		6.3AC	0		7.6	13							
V21	130	13	15	6.3AC	6.3AC	132	14	15						
V22	0	2.8	6.3AC	0	65	150	2.8							
V23	250	−30	.03	6.3AC	6.3AC	250	−30	.03						
V24	76		6.3AC	0		.25*	0							
V25	0	−6.0	6.3AC	0	.25		0							
V26	242	2.5	16	6.3AC	6.3AC	2.5	.25*							
V27	220	0	3.8	6.3AC	6.3AC	242	0*	3.8						
V28	−1.3*	−1.3*	0	6.3AC	6.3AC	234	0*	9.2						
V29	142	−1.3*	0	6.3AC	6.3AC	363	−13*	0						
V301	0		0		1.2	6.3AC		158						

REMARKS: *VTVM readings, all others on 20,000 ohm per volt meter. (see SECTION 7 Par. 2*a* (3)).

CONTROL	*SETTING*
V MULTIPLIER	300
V GAIN	Max. CCW
SWEEP RANGE	5-50
SYNC	INT-TRIGGER
CAL	OFF
FINE SWEEP	Max. CW
SWEEP DELAY	OUT
H GAIN	For 2½" trace
SWEEP STABILITY	PULSE TRIG
MARKER μS	BEAM MOD
TRIGGER	300
S8	115

LINE VOLTAGE AT 115V 60 CYCLES

TABLE 7—8. RESISTANCE CHART FOR AN/USM-24C

TUBES	PIN NUMBERS													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
V1	2.2M	91	HTR	0	(Q) 10.2K	(Q) 51K	91							
V2	(R) 16.7K	2.2M	270	HTR	HTR	(Q) 9K	1.51M	10.5K						
V3	10M	0	HTR	0	(R) 6.2K	(R) 4.4K	0							
V4	1M	847	HTR	0	(R) 1.5K	(R) 2.2K	847							
V5	1M	847	HTR	0	(R) 1.8K	(R) 2.3K	847							
V6	(Z)# 40K	(Z)# 140K	(Z) 660K		(Z)# 850K		(S) 2.2M	(T) 2.2M	220K	(O) 0	(N) 0			(Z)# 40K
V7	(X) 13.3K	(X) 1.3M	0	HTR	HTR	(X) 13.3K	(X) 1.3M	0						
V8	64			HTR	0		# 22K		64					
V9	64			HTR	0		# 22K		64					
V10	64			HTR	0		# 22K		64					
V11	64			HTR	0		# 22K		64					
V12				(F)# 470K	(F)# 470K				# 220K					
V13				# 220K	# 220K				(Z) 470K					
V14	(W) 2.7K	1M	880	HTR	HTR	(W) 4.9K	1M	570						
V15	(W) 23.5K	0	HTR	0	1M		(W) 16.2K							
V16	(W) 16.2K	# 110K	1K	HTR	HTR	(W) 23.5K	1M	1K						
V17	(W) 1.5K	(W) 16.2K	18K	HTR	HTR	(W) 9.8K	# 125K	0						
V18	9.1K	9.1K	10.5K	HTR	HTR	(X) 15K	(V)# 560K	9.1K						
V19					(W) 2K		0							
V20	(X) 0		HTR	0		# 7.1K	3.3K							
V21	(X) 2K	3.3K	950	HTR	HTR	(X) 1K	10.5K	950						
V22	56K	390	HTR	0	(W) 18K	(X) 47	390							
V23	(W) 360	338K	118	HTR	HTR	(W) 360	338K	118						
V24	(W) 27.6K		HTR	0		(V)# 420K	0							

TABLE 7—8. RESISTANCE CHART FOR AN/USM-24C—Continued

TUBES	PIN NUMBERS													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
V25	6.2M	1.2K	HTR	0	(V)# 420K		0							
V26	(W) 2.2K	(W) 1.08M	11.8K	HTR	HTR	(W) 1.08M	(V)# 420K	0						
V27	(W) 21K	1M	(V) 47K	HTR	HTR	(W) 2.2K	0	(V) 47K						
V28	10M	10M	0	HTR	HTR	(U) 47K	1.5M	1.8K						
V29	(U) 30K	10M	(V) 15K	HTR	HTR	(U) 37K	5.6M	(V) 15K						
V301	1M		0		680	HTR		(R) 12K						

REMARKS: Use equipment referenced in SECTION 7 Par. 2*a* (2) and 2*a* (3).

	CONTROL	*SETTING*
(R) Resistance to TB9-H	V MULTIPLIER	300
(S) Resistance to TB9-K	V GAIN	Max. CCW
(T) Resistance to TB9-M	SWEEP RANGE	5-50
(U) Resistance to TB8-C	SYNC	INT-TRIGGER
(X) Resistance to TB8-K	CAL	OFF
(F) Resistance to E-11	FINE SWEEP	Max. CW
(Z) Resistance to −1200	SWEEP DELAY	OUT
(W) Resistance to TB8-H	H GAIN	Max. CCW
(Q) Resistance to TB9-B	SWEEP STABILITY	PULSE TRIGGER
(V) Resistance to TB8-E	MARKER μS	BEAM MOD
(O) Resistance to TB7-2	TRIGGER	300
(N) Resistance to TB7-1	S8	115

All other reading to ground
Suffix "M" = x 1,000,000
Suffix "K" = x 1000
#Reading is dependent upon control and/or adjustment settings. See schematic diagram.

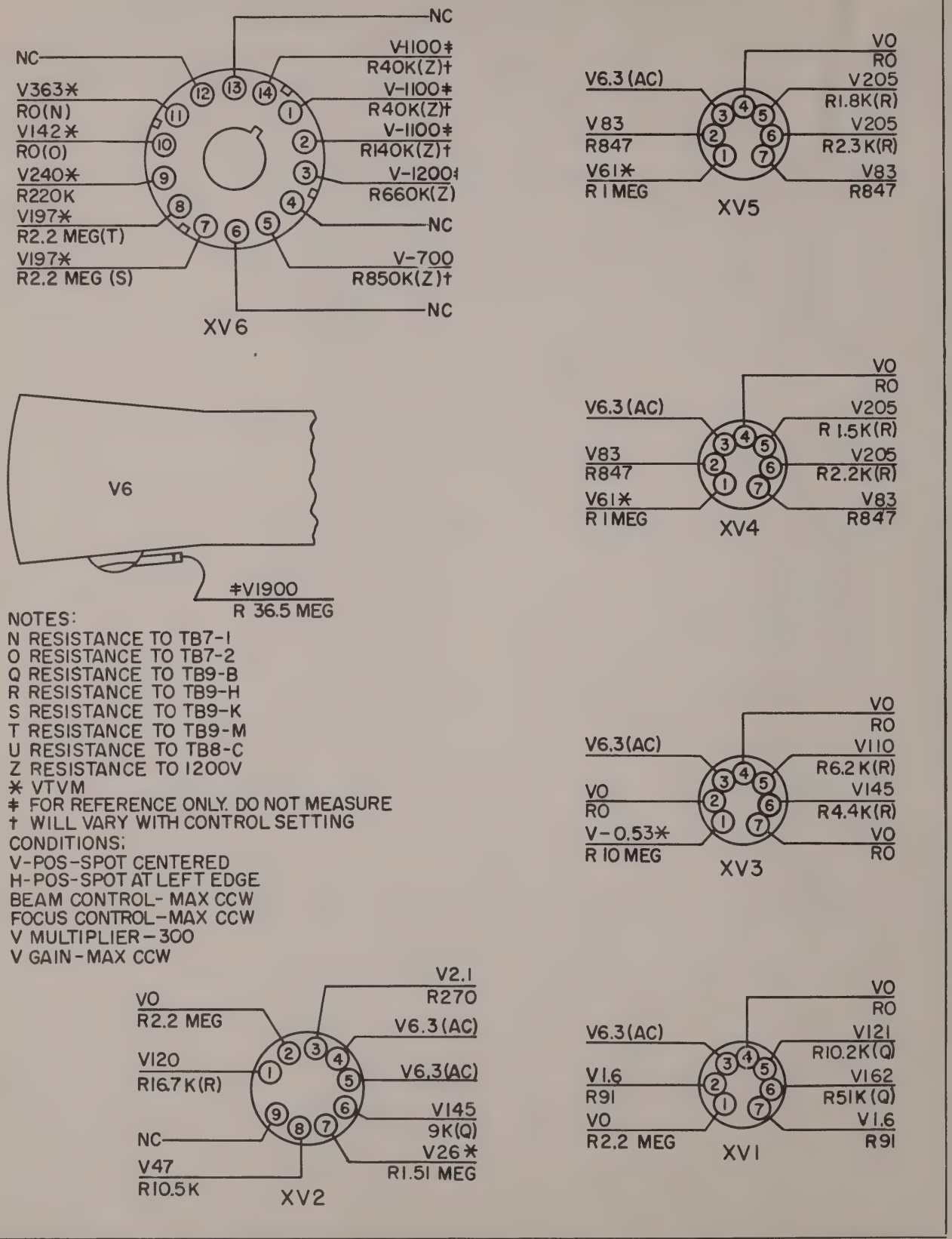


Figure 7—16. Voltages and Resistances from Tube Socket Terminals to Ground or Terminal Board Connections, Upper Left Hand Chassis and C. R. T.

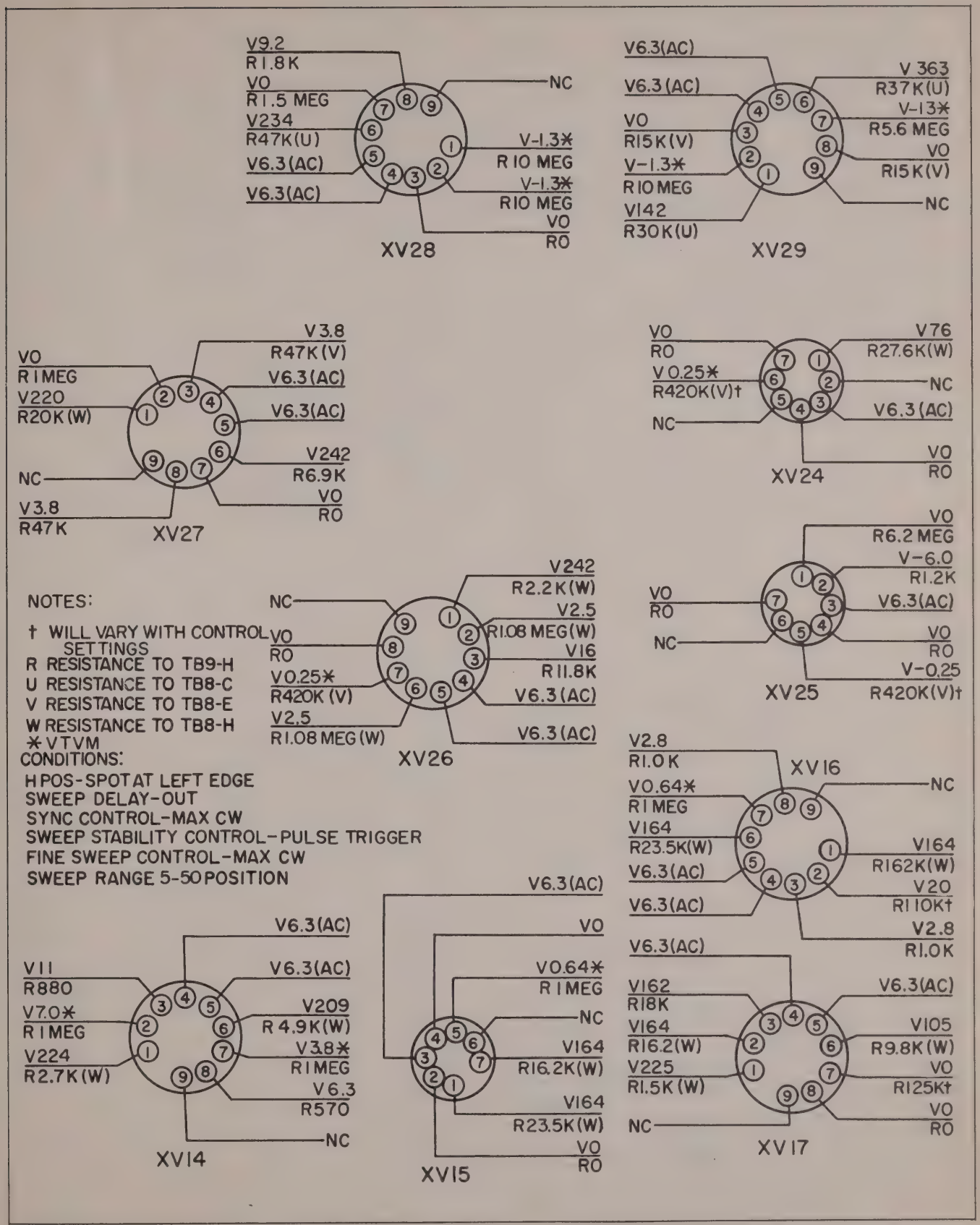
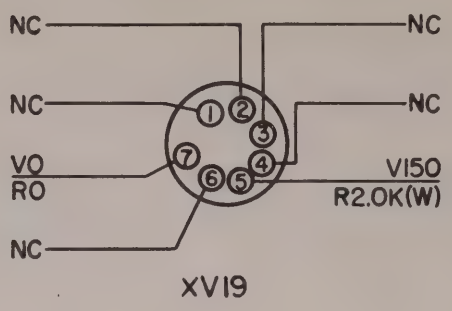
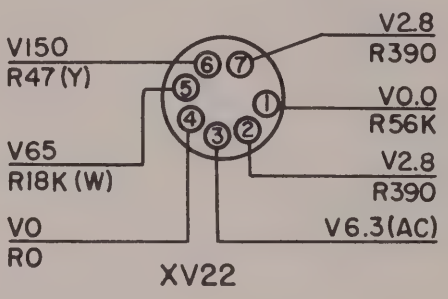


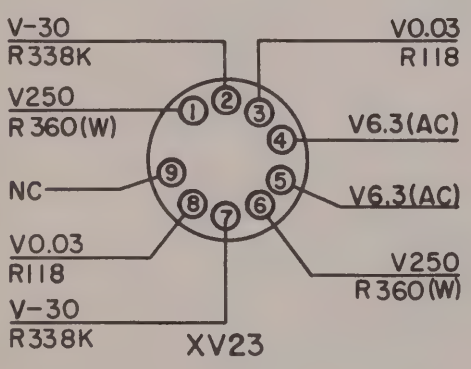
Figure 7—17. Voltages and Resistances from Tube Socket Terminals to Ground or Terminal Board Connections, Upper Right Hand Chassis

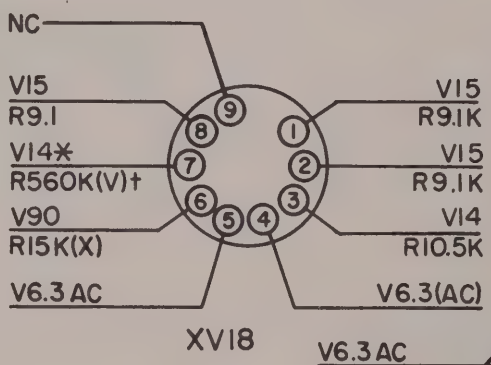
NOTES:
V RESISTANCE TO TB8-E
W RESISTANCE TO TB8-H
X RESISTANCE TO TB8-K
Y RESISTANCE TO +1900
Z RESISTANCE TO −1200
* VTVM
# FOR REFERENCE ONLY—DO NOT MEASURE
† WILL VARY WITH CONTROL SETTINGS

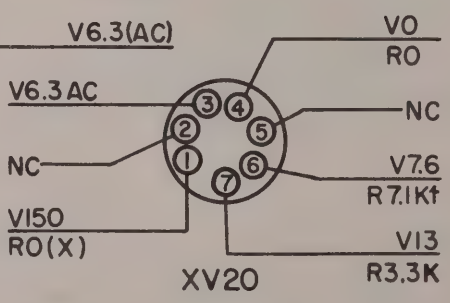
CONDITIONS:
V POS—SPOT CENTERED
H POS—SPOT AT LEFT EDGE
BEAM CONTROL—MAX CCW
FOCUS CONTROL—MAX CCW
MARKER μS—BEAM MOD POSITION
TRIGGER PPS—300











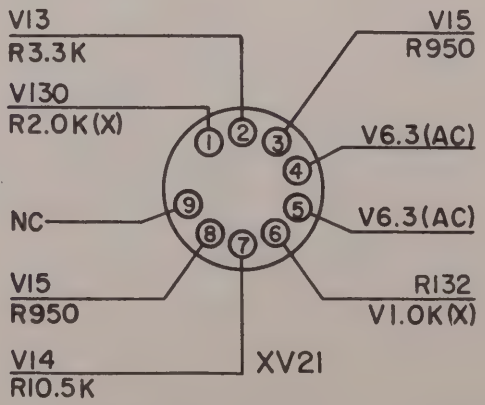


Figure 7—18. Voltages and Resistances from Tube Socket Terminals to Ground or Terminal Board Connections, Lower Chassis

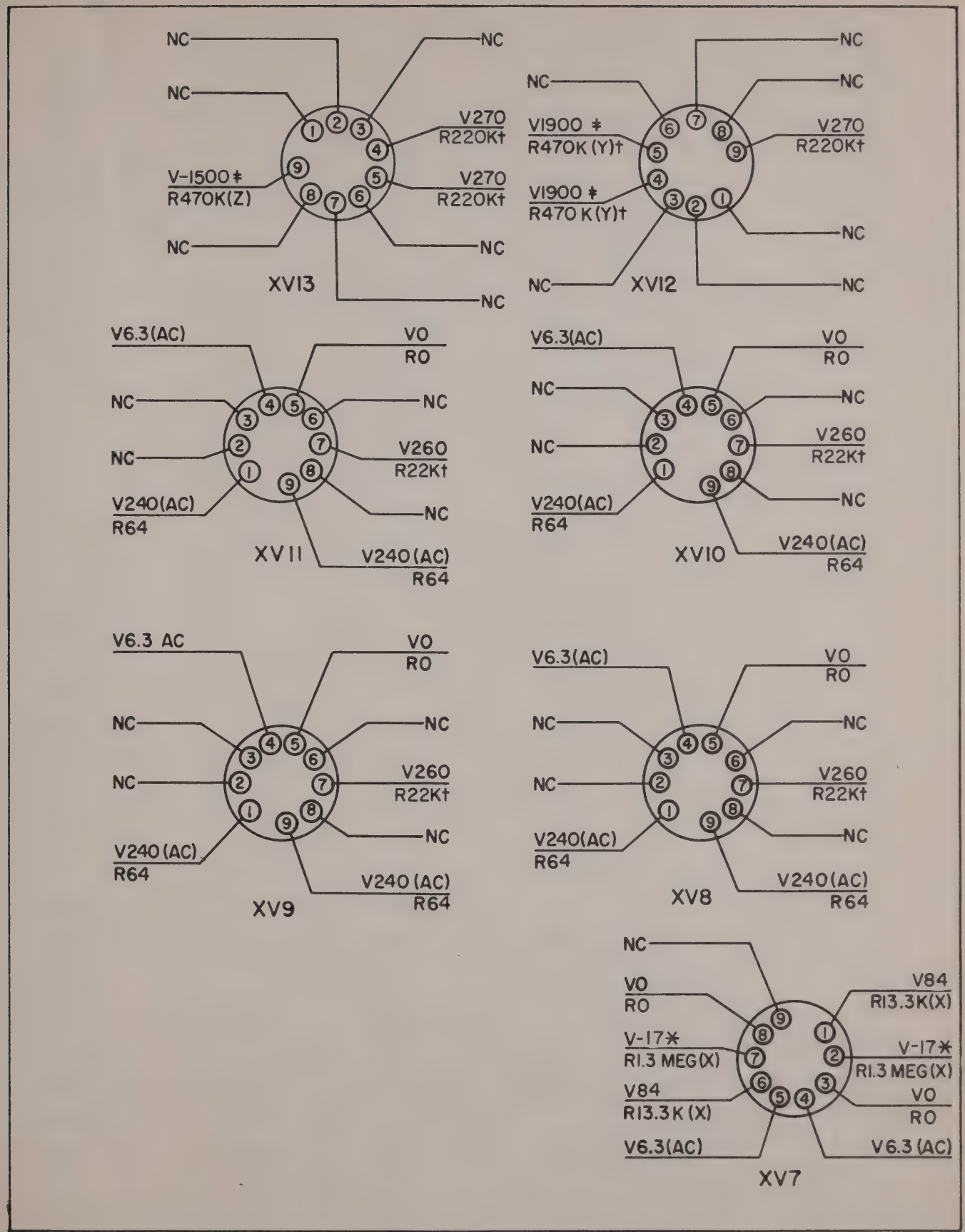


Fig. 7—18. (Continued)

TABLE 7—9. SYMBOLS AND FIGURE NUMBERS

SYMBOL NUMBER	FIGURE NUMBER
A1 to A4	7—19
A7	7—19
B1 to B1C	7—6
C1 to C10	7—30
C11 to C13	7—25
C14	7—20
C15	7—34
C16	7—44
C17, C18	7—25
C19 to C21	7—34
C22 to C25	7—39
C26, C27	7—27
C28 to C35	7—41
C36	7—25
C37	7—28
C38	7—25
C39 to C43	7—42
C44 to C46	7—43
C47	7—36
C48	7—24
C49	7—36
C50	7—20
C51	7—36
C52	7—37
C53	7—26
C54 to C58	7—32
C59, C60	7—20
C61	7—38
C62	7—26
C63	7—38
C64	7—28
C65, C66	7—31
C67	7—39
C68 to C70	7—31
C71	7—27
C72 to C77	7—31
C78	7—40
C79	7—33
C80	7—40
C81	7—33
C82	7—38
C83	7—26
C84, C85	7—38
C86	7—37
C87 to C90	7—32
C91	7—20
C92	7—26
C93	7—38
C94	7—26
C95, C96	7—36
C97 to C99	7—26
C100	7—38
C101, C102	7—25
C103	7—20
C104	7—30
CR1 to CR3	7—27
DL1	7—20
DS1, DS2	7—19
DS3, DS4	7—20
E1	7—19
E2, E3	7—21
E4, E5	7—19
E6	7—6
E7, E8	7—7
E9	7—25
E11	7—27
E12	7—23
E13	7—27
E14, E15	7—20
E16, E17	7—23
E18	7—27
E19	7—24
E20	7—23
F1 to F4	7—19
FL1	7—29
HR1	7—27
J1 to J10	7—19
L1 to L6	7—25
L7	7—28
L8	7—26
L9	7—38
L10	7—31
L11	7—40
L12	7—40
L13, L14	7—38
L15	7—20
L16	7—44
L17	7—26
MP1, MP2	7—19
MP3	7—26
MP4	7—25
MP5	7—28
MP6	7—22
MP7	7—29
MP8	7—36
MP11	7—38

TABLE 7—9. SYMBOLS AND FIGURE NUMBERS—Continued

SYMBOL NUMBER	FIGURE NUMBER
MP12	7—7
MP13	7—44
MP14	7—27
MP15	7—25
N1, N2	7—19
R1 to R11	7—30
R12 to R16	7—25
R17	7—34
R18	7—25
R19 to R22	7—34
R23	7—20
R24	7—44
R25, R26	7—29
R27 to R30	7—25
R31, R32	7—34
R33, R34	7—25
R35	7—20
R36 to R38	7—25
R39, R40	7—35
R41 to R43	7—25
R44	7—34
R45	7—25
R46, R47	7—35
R48, R49	7—34
R50	7—23
R51	7—19
R52	7—29
R53 to R57	7—39
R58	7—29
R59 to R61	7—39
R62	7—29
R63, R64	7—39
R65	7—40
R66	7—24
R67	7—28
R68 to R77	7—41
R78	7—23
R79, R80	7—25
R81, R82	7—42
R83 to R90	7—41
R91, R92	7—42
R93	7—43
R94	7—39
R95, R96	7—43
R97	7—42
R98	7—29
R99	7—36
R100	7—24
R101 to R105	7—26
R106	7—19
R107 to R111	7—26
R112, R113	7—37
R114	7—26
R115	7—37
R116 to R118	7—38
R119	7—32
R120	7—26
R121 to R124	7—38
R125 to R127	7—26
R128	7—38
R129	7—40
R130	7—24
R131	7—40
R132	7—28
R133, R134	7—40
R135	7—24
R136	7—28
R137	7—40
R138 to R140	7—31
R141, R142	7—24
R143 to R147	7—31
R148, R149	7—40
R150	7—28
R151 to R157	7—40
R158 to R167	7—33
R168	7—24
R169, R170	7—38
R171	7—26
R172	7—37
R173	7—38
R174	7—26
R175	7—37
R176, R177	7—38
R178	7—37
R179, R180	7—38
R181 to R183	7—26
R184	7—37
R185	7—38
R186, R187	7—26
R189	7—36
R190	7—26
R191, R192	7—38
R193	7—26
R194	7—26
R195	7—26
R196	7—29

TABLE 7—9. SYMBOLS AND FIGURE NUMBERS—Continued

SYMBOL NUMBER	FIGURE NUMBER
R197 to R204	7—38
R205, R206	7—25
R207, R208	7—41
R209	7—24
R210	7—28
R211	7—42
R212	7—40
R213, R214	7—27
R215	7—28
R216	7—25
R217	7—39
R218	7—26
R219	7—29
S1	7—30
S2	7—25
S3	7—21
S4	7—38
S5	7—19
S6, S7	7—21
S8	7—19
S9	7—29
S10	7—19
S11	7—32

SYMBOL NUMBER	FIGURE NUMBER
S12	7—26
S13	7—31
S14	7—33
S15	7—26
T1, T2	7—28
TB1	7—30
TB2	7—25, 7—34
TB3	7—25, 7—35
TB4	7—21, 7—25
TB5	7—20, 7—36
TB6	7—26, 7—37
TB7	7—26, 7—38
TB8, TB9	7—27
TB10, TB11	7—27, 7—39
TB12	7—28, 7—40
TB13	7—28, 7—41
TB14	7—28, 7—42
TB15	7—28, 7—43
TB16	7—25, 7—44
V1 to V6	7—20
V7 to V13	7—27
V14 to V17	7—20
V18 to V23	7—27

SYMBOL NUMBER	FIGURE NUMBER
V24 to V29	7—20
XDS1, XDS2	7—29
XDS3, XDS4	7—20
XF1 to XF4	7—29
XV1 to XV5	7—25
XV6	7—20
XV7 to XV13	7—28
XV14 to XV17	7—26
XV18 to XV23	7—28
XV24 to XV29	7—26
Z1	7—20, 7—30
Z2	7—28, 7—31
Z3	7—20, 7—32
Z4	7—28, 7—33
C301	7—8
C302, C303	7—9
C304	7—8
L301	7—9
P301, P302	7—9
P303	7—8
R301	7—8
R302 to R305	7—9
V301	7—9

SYMBOL NUMBER	FIGURE NUMBER
A301—Same as CW-362/USM-24C	1—3
E301—Same as UG-255/U	1—3
E302—Same as UG-924/U	1—3
E303—Same as UG-274/U	1—3
E304—Same as UG-273/U	1—3
E305—Same as UG-201A/U	1—3
E306—Same as UG-349A/U	1—3
H301—Same as Wrench, Allen No. 6	1—3
H302—Same as Wrench, Allen No. 8	1—3

SYMBOL NUMBER	FIGURE NUMBER
H303—Same as Wrench, Allen No. 4	1—3
H304—Same as Wrench, Spanner TWA003-002	1—3
P304, P305—P/O Lead Test CG-409/U (8′0″)	1—3
P306—P/O Cable CX-3092/USM-24C	1—3
W301—Same as CG-409/U (8′0″)	1—3
W302—Same as CX-3092/USM-24C	1—3
W303—Same as CG-883A/USM-24	1—3
W304—Same as CG-1277/USM-24C	1—3

TABLE 7—10. WINDING DATA

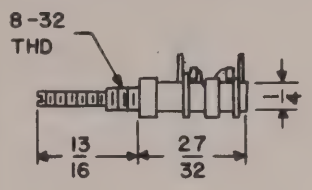
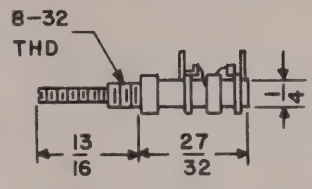
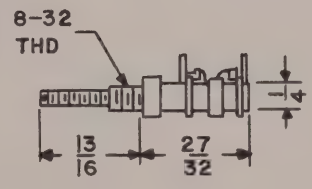
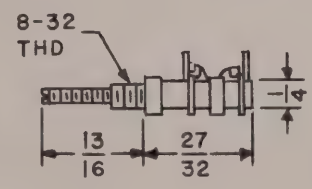
DESIGNATION SYMBOL	WATERMAN PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	DC RESISTANCE IN OHMS	HIPOT AC VOLTS	REMARKS
L1	LLV005 002		Universal Single	38SSE	37	1.72		Center inductance 13 microhenries at 1 megacycle
L2 L6	LLV005 009		Universal Single	38SNN	43	2.2		Center inductance 25 microhenries at 1 megacycle
L3 L4	LLV00 004		Universal Single	38SSE	60	3.05		Center inductance 36 microhenries at 1 megacycle
L5	LLV005 003		Universal Single	38SSE	42	1.88		Center inductance 15 microhenries at 1 megacycle
L7	LCB009 A01		Single	27E	2100	65	800	5 HY at 265 MA DC

TABLE 7—10. WINDING DATA—Continued

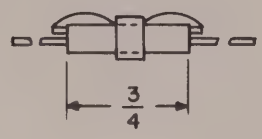
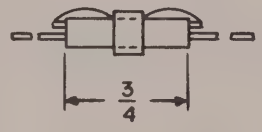
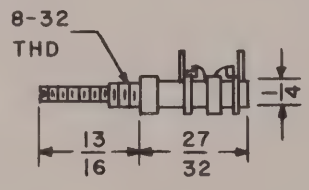
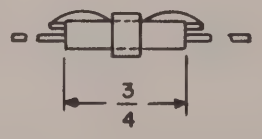
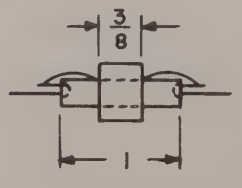
DESIGNATION SYMBOL	WATERMAN PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	DC RESISTANCE IN OHMS	HIPOT AC VOLTS	REMARKS
L8	LLU024 001		Universal Single	3/42 Litz H Nylon	86	3.14		Inductance 100 microhenries ±10% at 500 kilocycles
L9	LLU024 002		Universal Single	3/42 Litz H Nylon	108	4.19		Inductance 155 microhenries ±10% at 500 kilocycles
L10 L12	LLV005 008		Universal Single	38SNN	62	3.8		Center inductance 43 microhenries at 1 megacycle
L11	LLU024 003		Universal Single	38SNN	58	2.69		Inductance 57 microhenries ±10% at 500 kilocycles
L13 L14	LLU022 001		Universal Single	38SSE	875	56		Inductance 11 millihenries ±10% at 100 kilocycles

TABLE 7—10. WINDING DATA—Continued

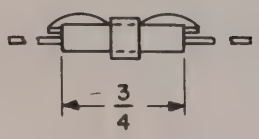
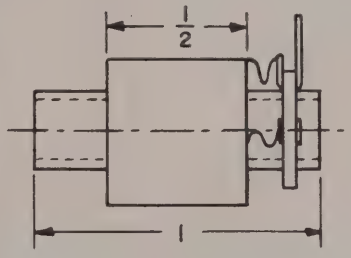
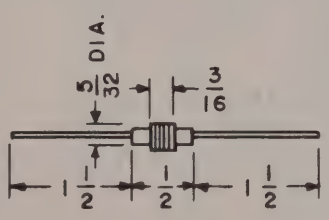
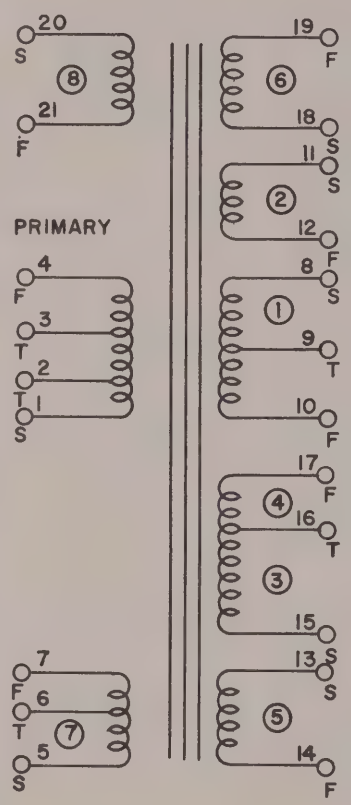
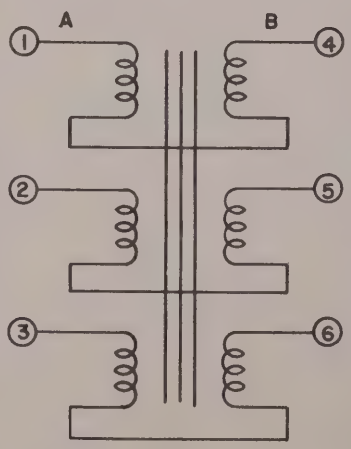
DESIGNATION SYMBOL	WATERMAN PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	DC RESISTANCE IN OHMS	HIPOT AC VOLTS	REMARKS
L15 L16	LLU024 004		Universal Single	3/42 Litz H Nylon	21	0.78		Inductance 8.4 microhenries at 1 megacycle
L17	LLU025 001		Universal Single	#39 SNE	1130	102		Inductance 5 millihenries ±5%
L301	LLU020 001		Single	34E	28			Inductance 1.9 microhenries at 9.5 megacycles

TABLE 7—10. WINDING DATA—Continued

DESIGNATION SYMBOL	WATERMAN PART NUMBER	DIAGRAM	WINDING	WIRE SIZE	TURNS	DC RESISTANCE IN OHMS	HIPOT AC VOLTS	REMARKS
T1	LPU015 A01							No Load Voltages / Full Load Voltage
			Primary	19E	219 Tap at 201 and 184	1.37	500	
			Secondary 1	28E	940 Tap at 470	50	800	530 / 495
			Secondary 2	38E	517	285	800	291 / 270
			Secondary 3	38E	2480	1400	3600	1400 / 1300
			Secondary 4	27E	2	.03	3600	1.13 / 1.125
			Secondary 5	27E	2	.03	3400	1.13 / 1.125
			Secondary 6	27E	27	1.65	500	15.25 / 14.5
			Secondary 7	14E	24 Tap at 12	.11	500	13.55 / 12.6
			Secondary B	21E	12	.22	500	6.76 / 6.3 *
T2	LZP001 A01							
			Inner 1A	36E	50	1.87		Inductance of 1A and 1B 4.5 to 7.5 millihenries at 1000 cycles.
			Middle 2A	36E	50	1.99		
			Outer 3A	36E	50	2.20		
			Inner 1B	36E	50	2.02		
			Middle 2B	36E	50	2.08		
			Outer 3B	36E	50	2.29		

* No load current, 0.35 amperes at 115 volts 60 cycles. Polarity additive. Impregnate transformer with stypol.
Primary 115V from 3 to 1 Primary 125V from 4 to 1 Primary 105V from 2 to 1

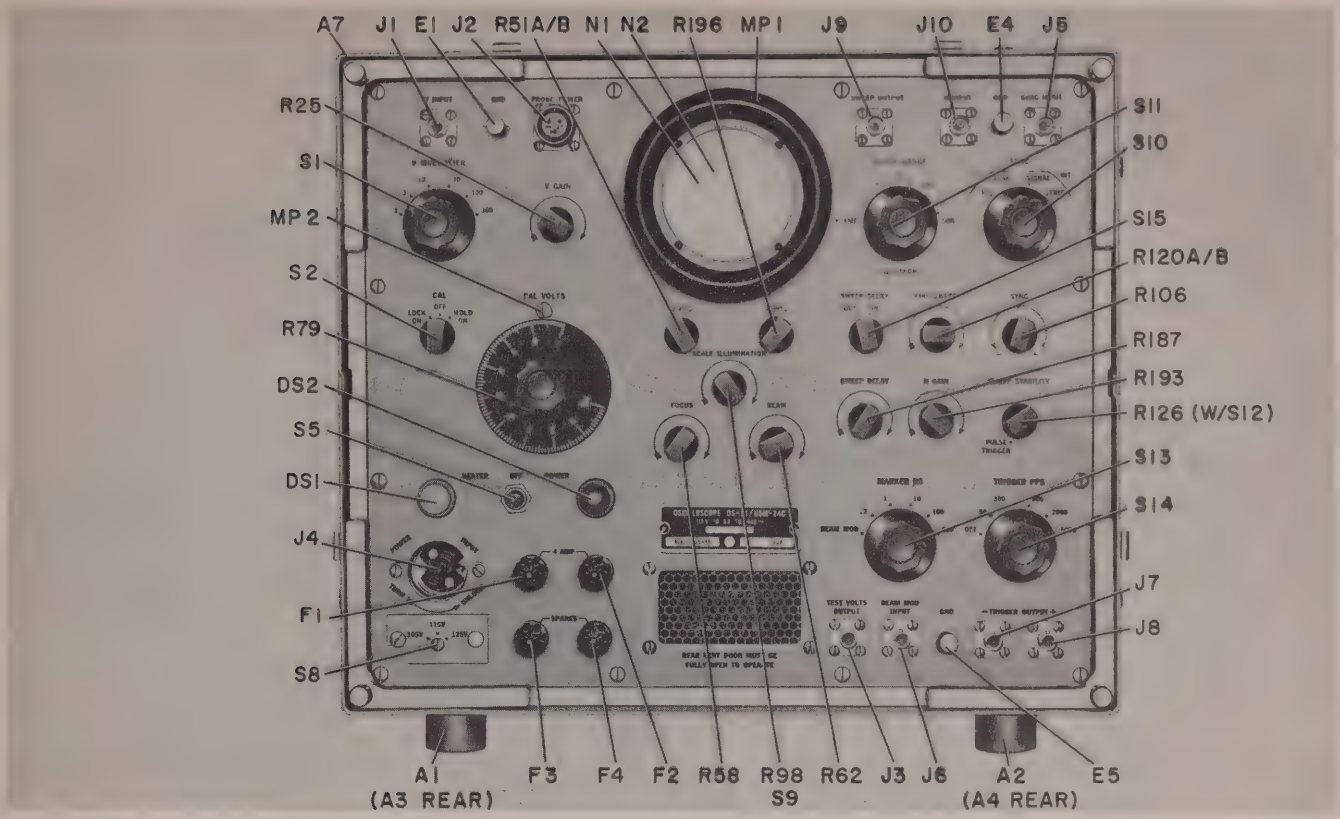


Figure 7—19. Oscilloscope OS-51/USM-24C, Front View

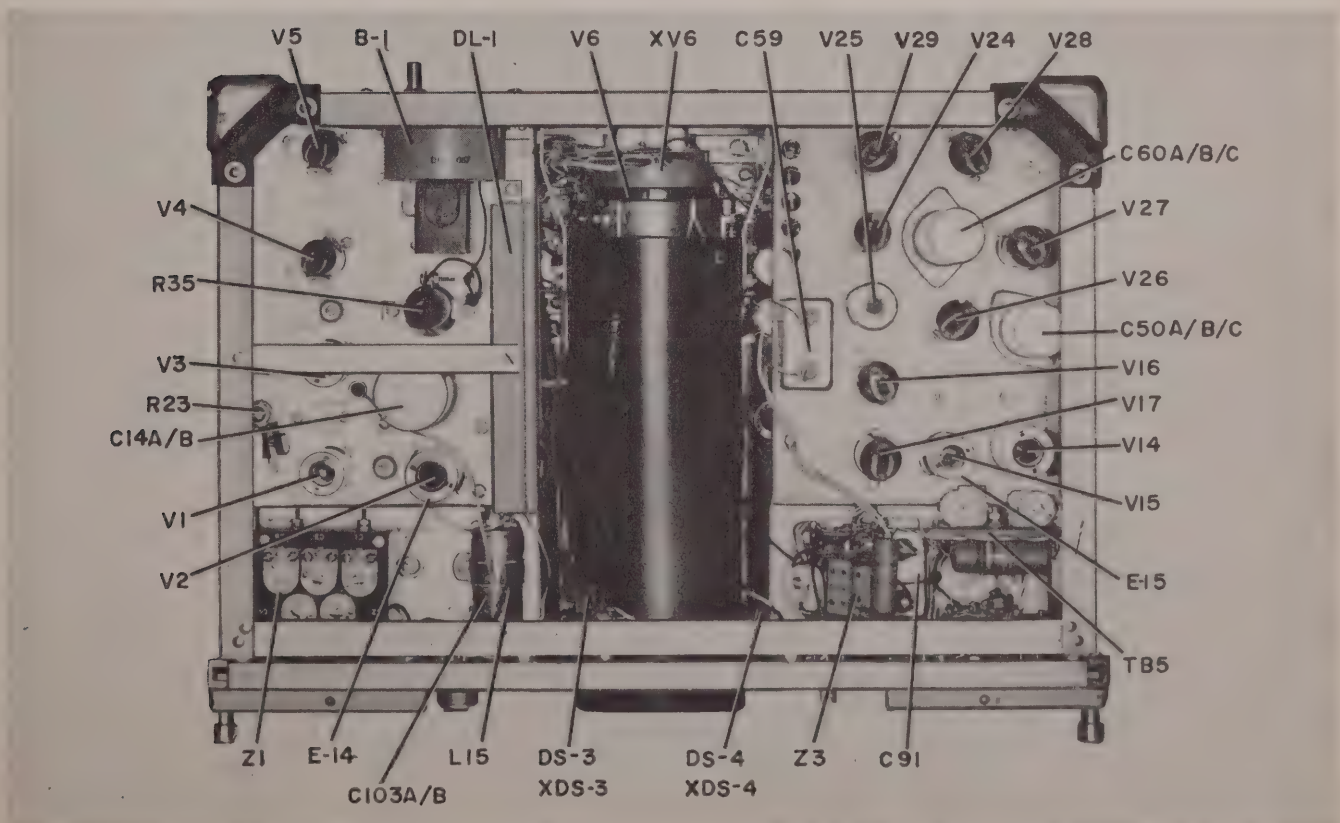


Figure 7—20. Oscilloscope OS-51/USM-24C, Top View without Case

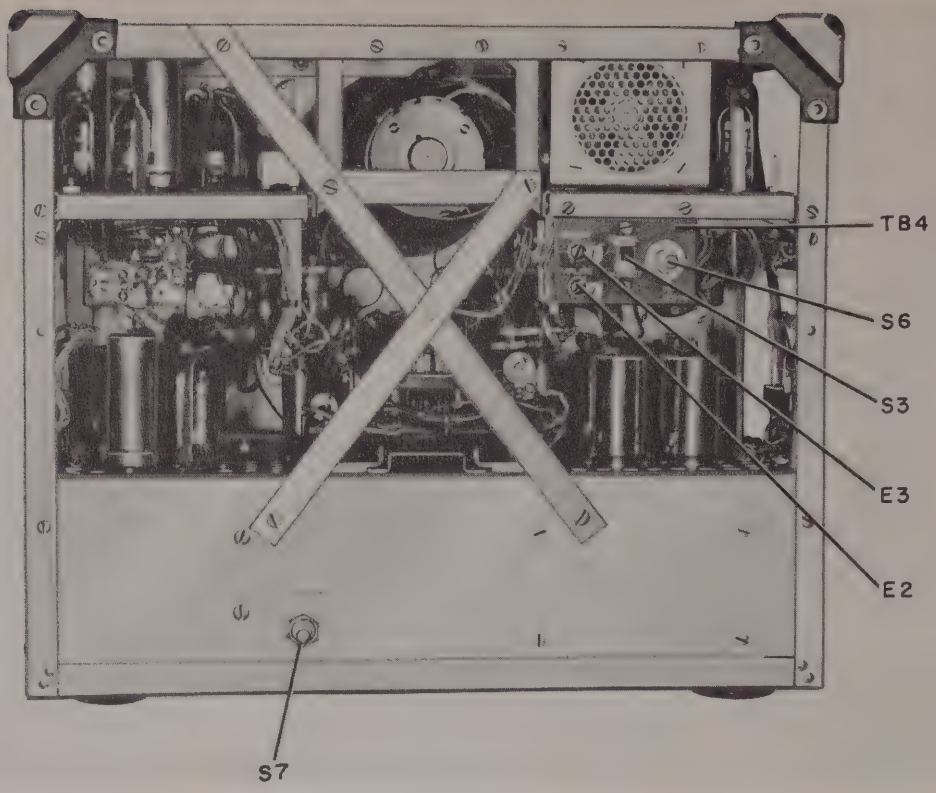


Figure 7—21. Oscilloscope OS-51/USM-24C, Rear View without Case

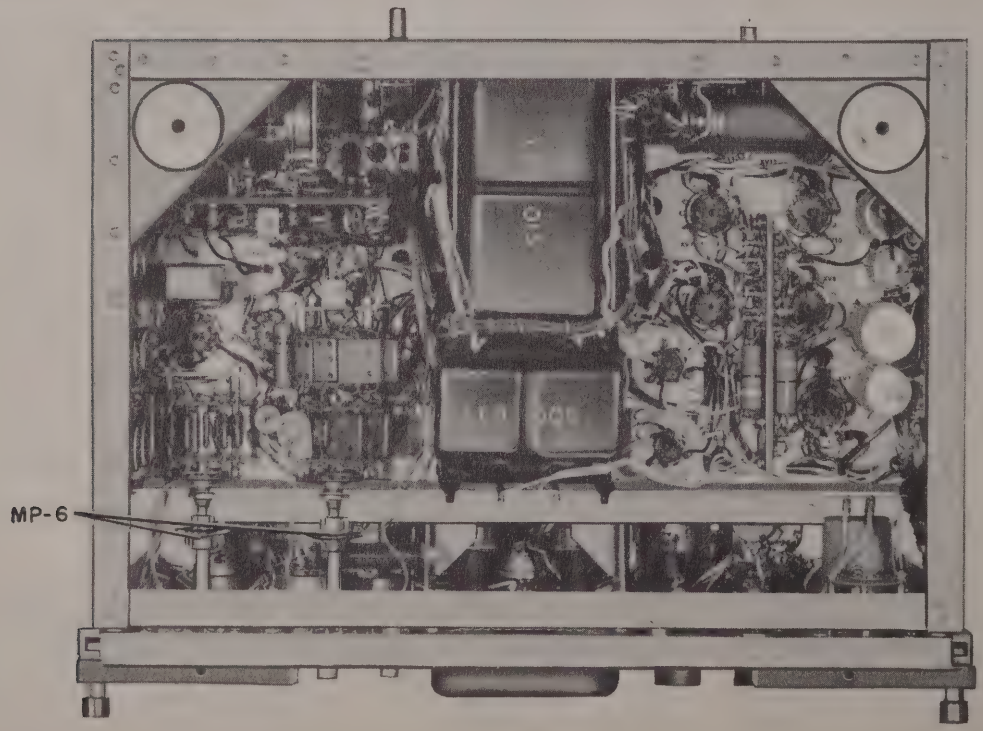


Figure 7—22. Oscilloscope OS-51/USM-24C, Bottom View without Case

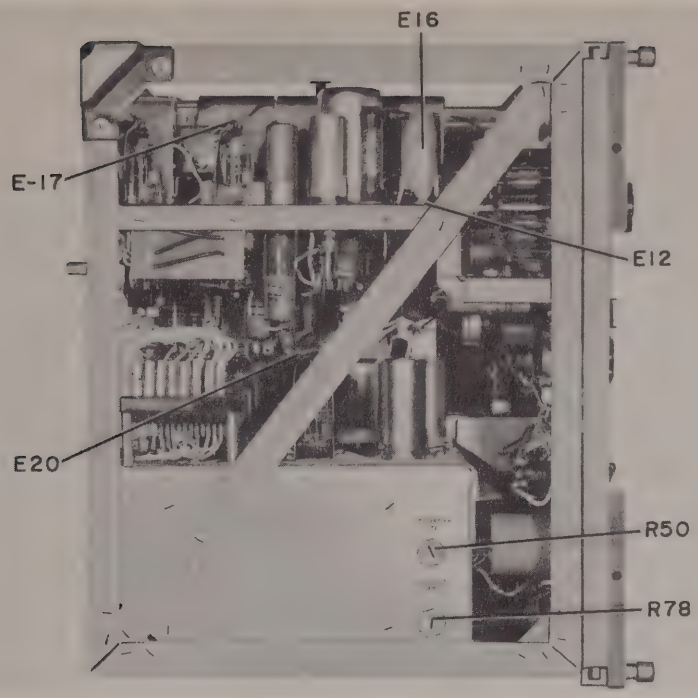


Figure 7—23. Oscilloscope OS-51/USM-24C, Left Side View without Case

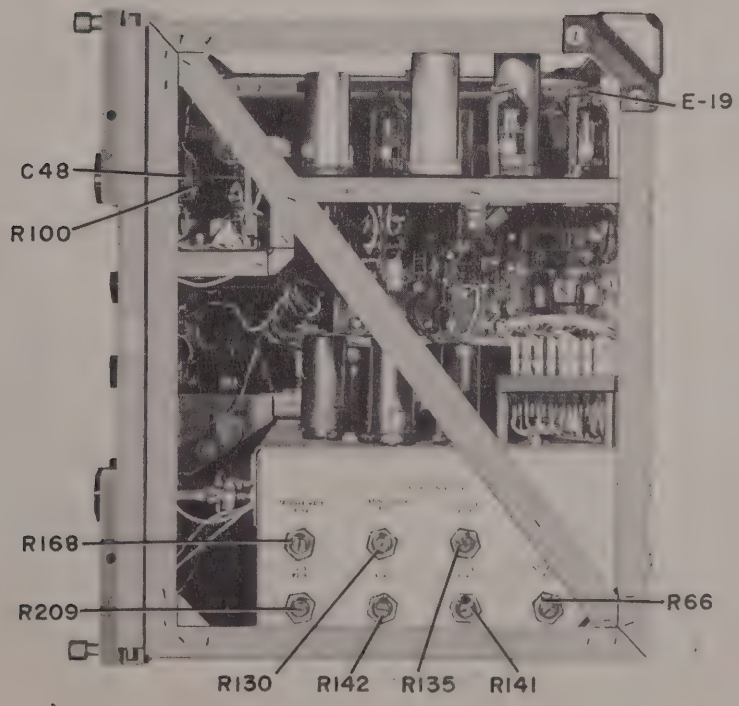


Figure 7—24. Oscilloscope OS-51/USM-24C, Right Side View without Case

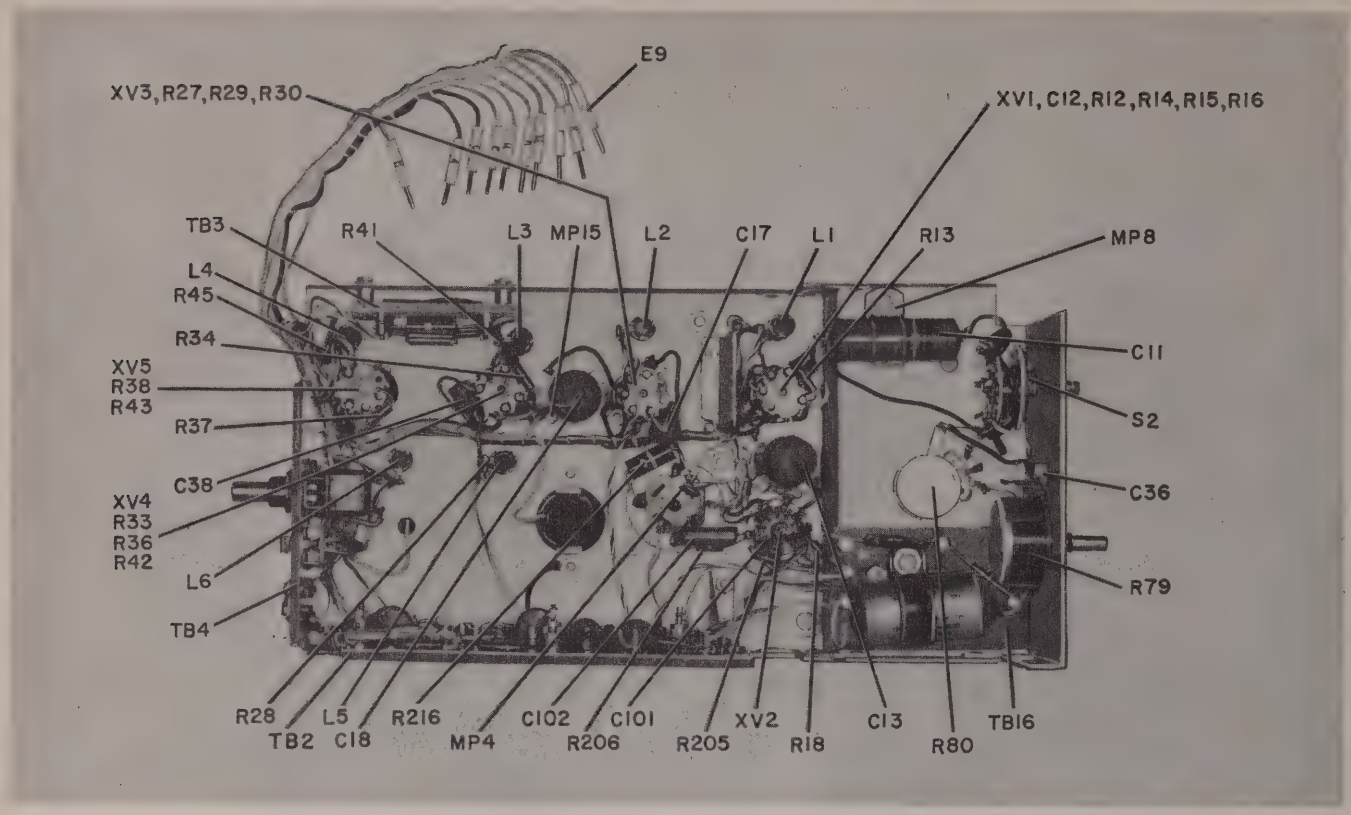


Figure 7—25. Upper Left Hand Chassis, Bottom View

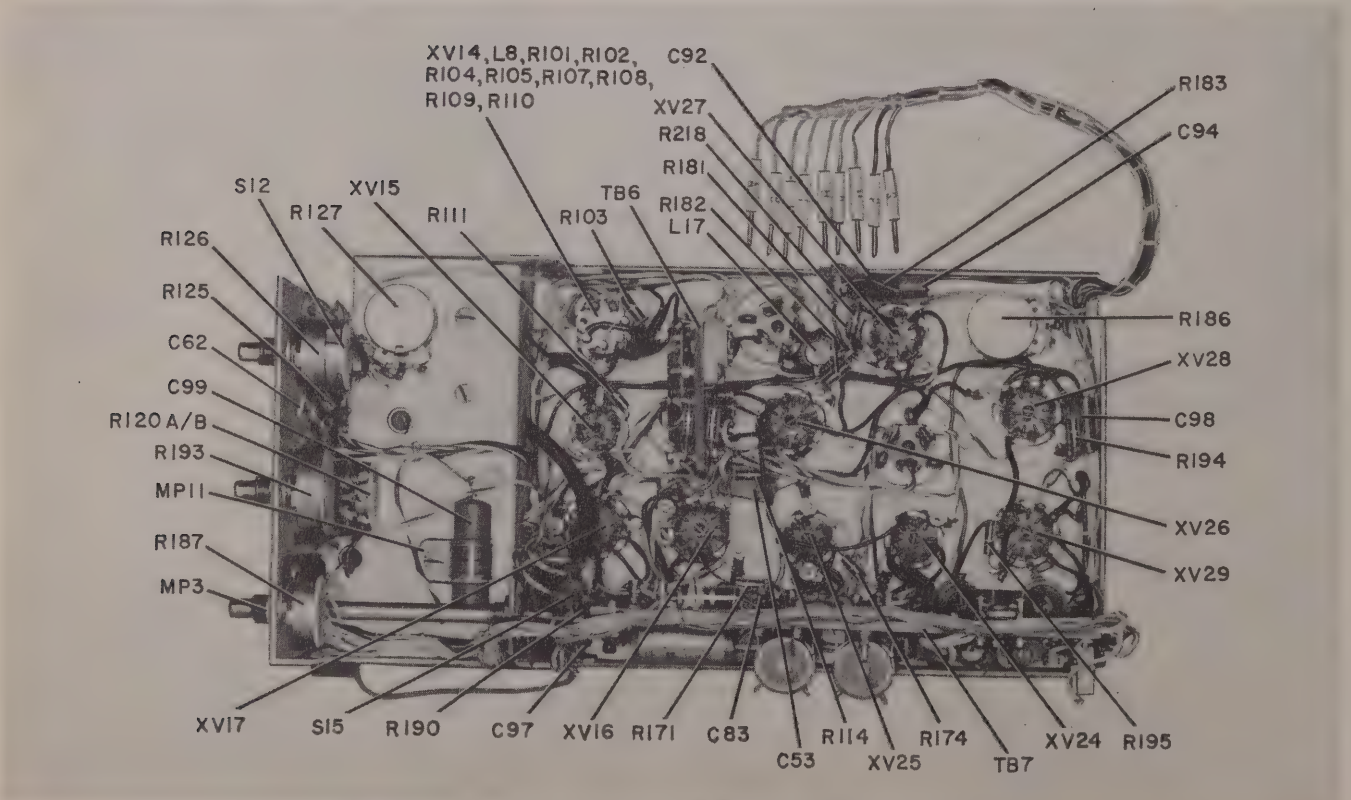


Figure 7—26. Upper Right Hand Chassis, Bottom View

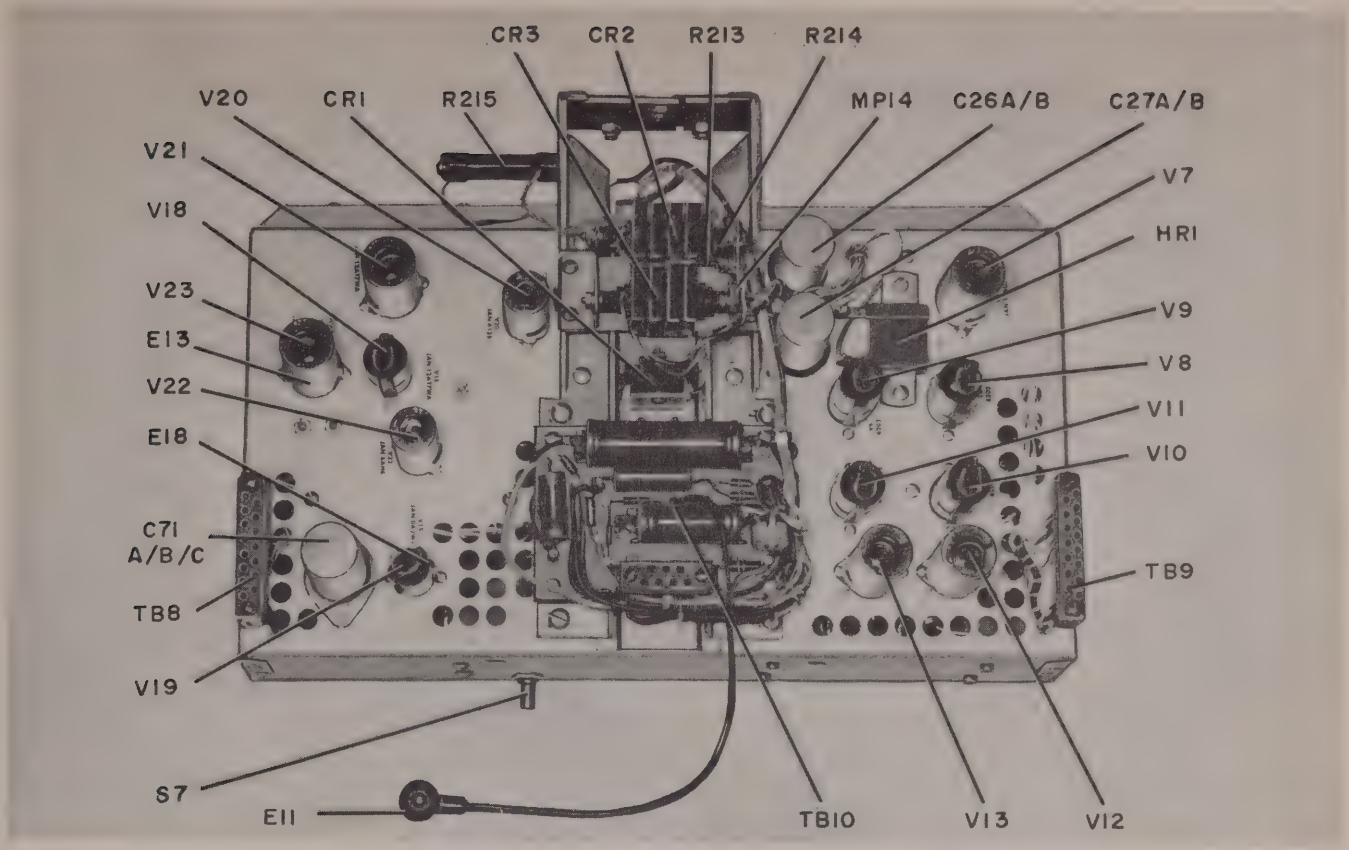


Figure 7–27. Lower Chassis, Top View

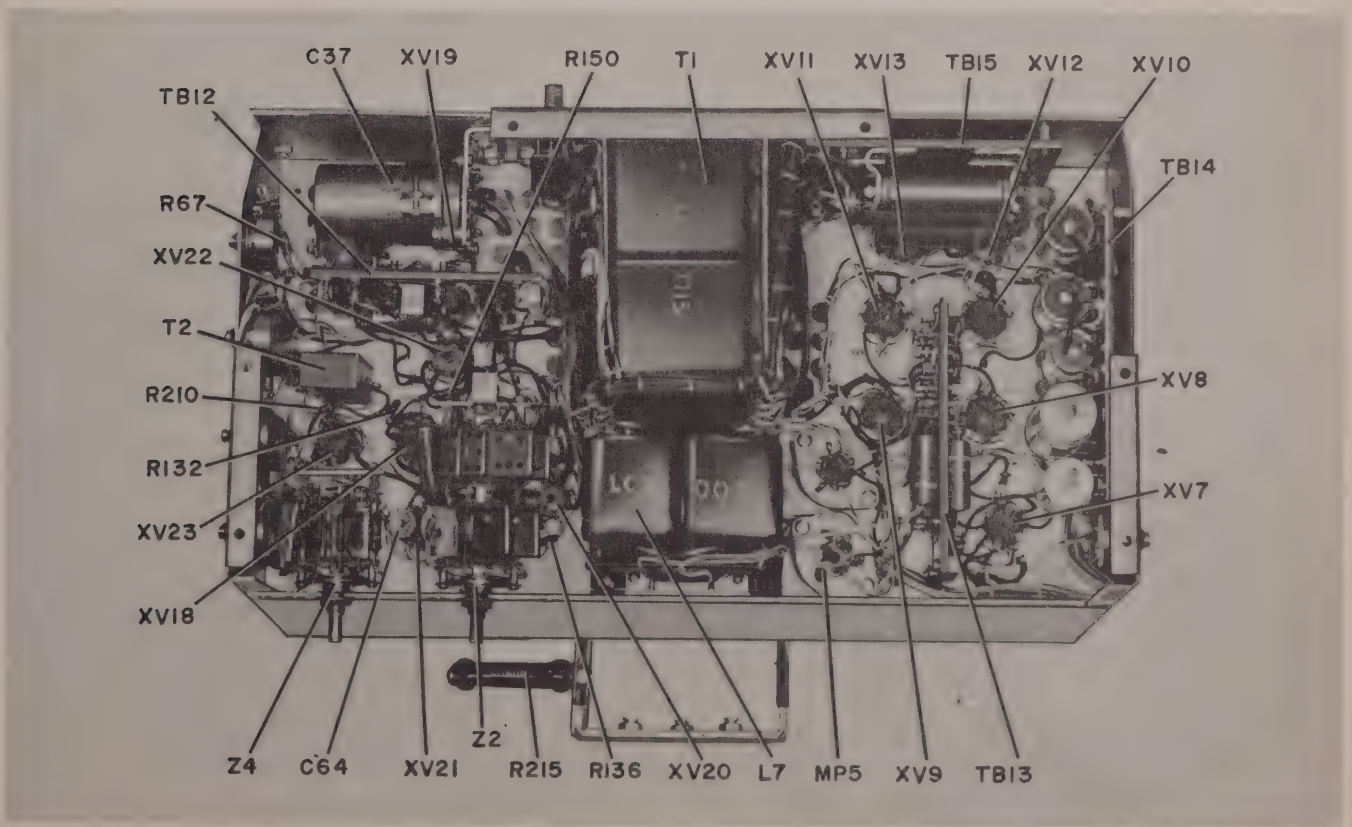


Figure 7–28. Lower Chassis, Bottom View

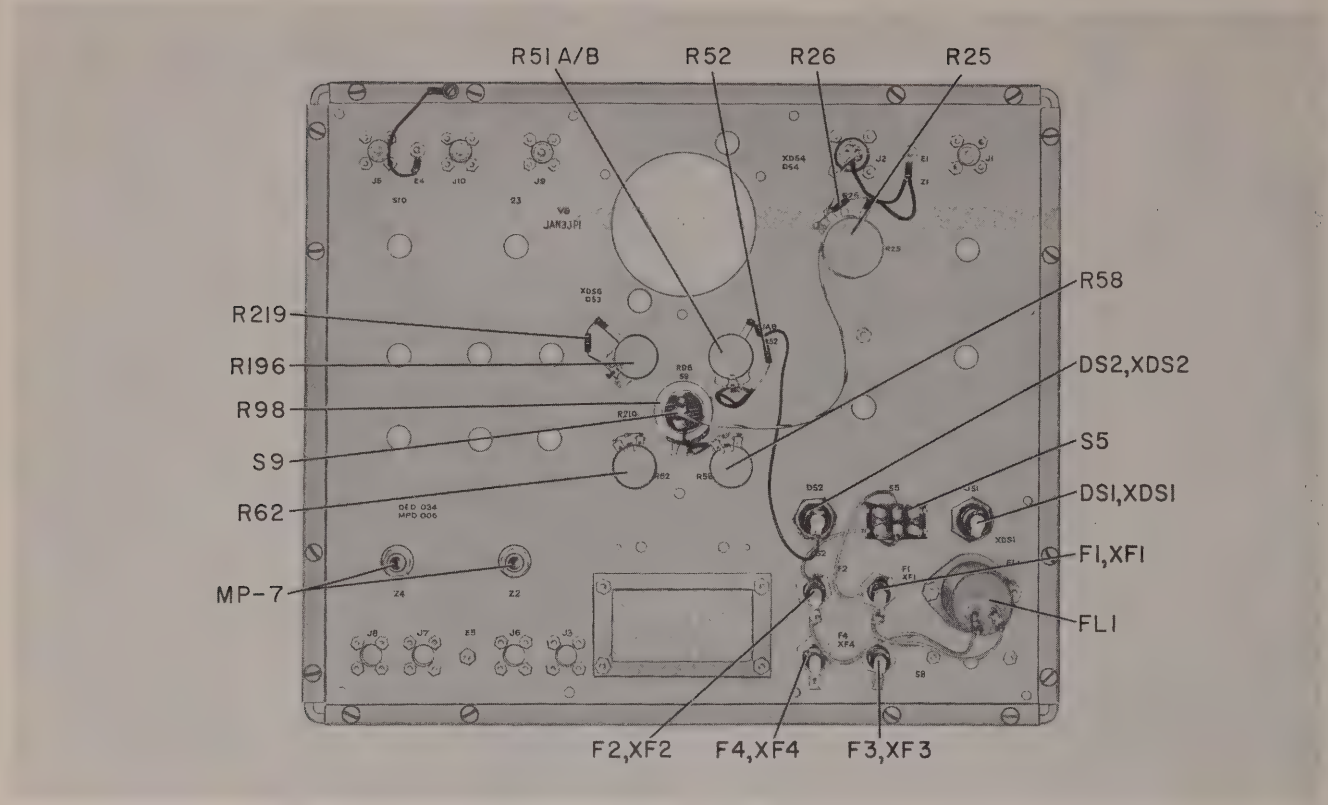


Figure 7—29. Front Panel, Rear View

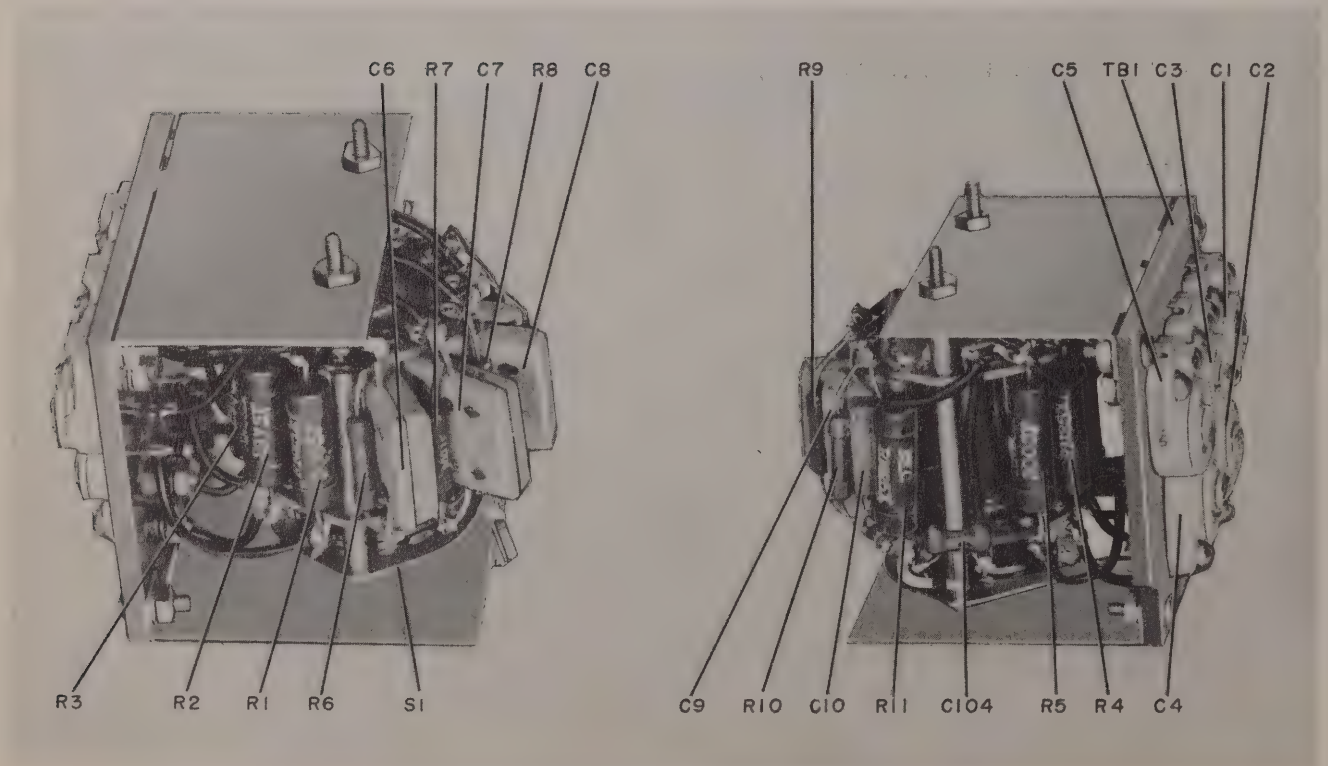


Figure 7—30. V MULTIPLIER, Assembly Z1

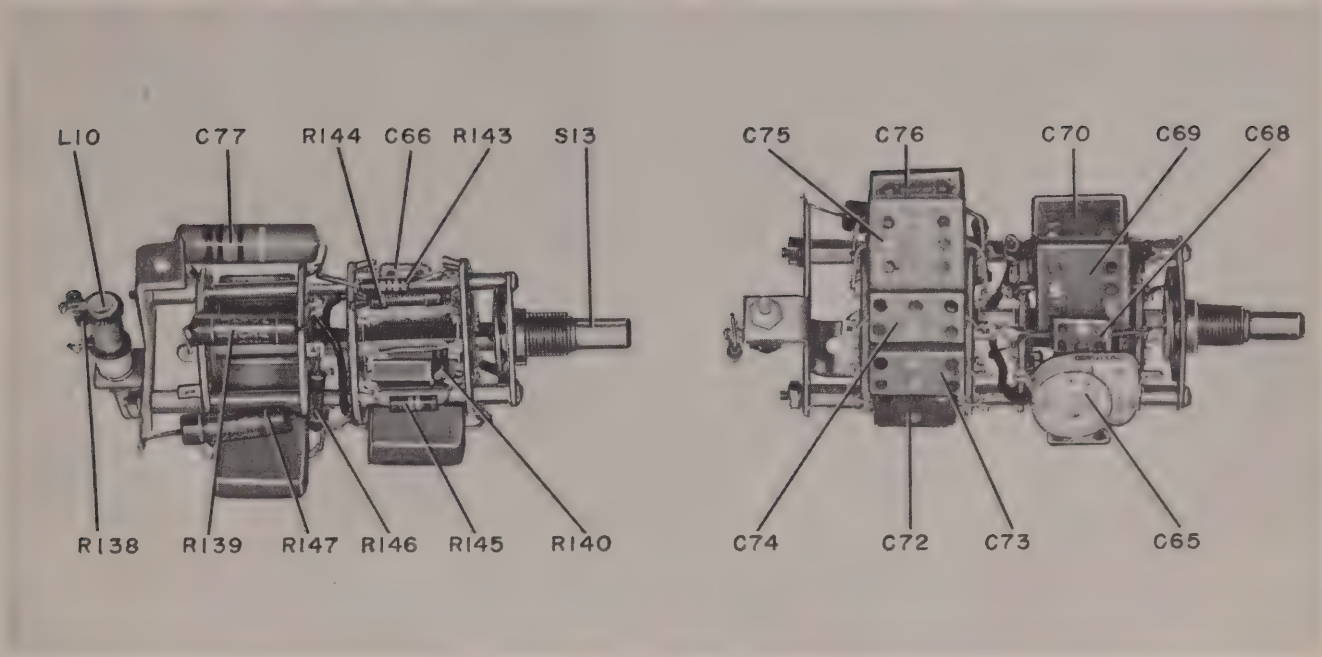


Figure 7—31. MARKER U/S, Assembly Z2

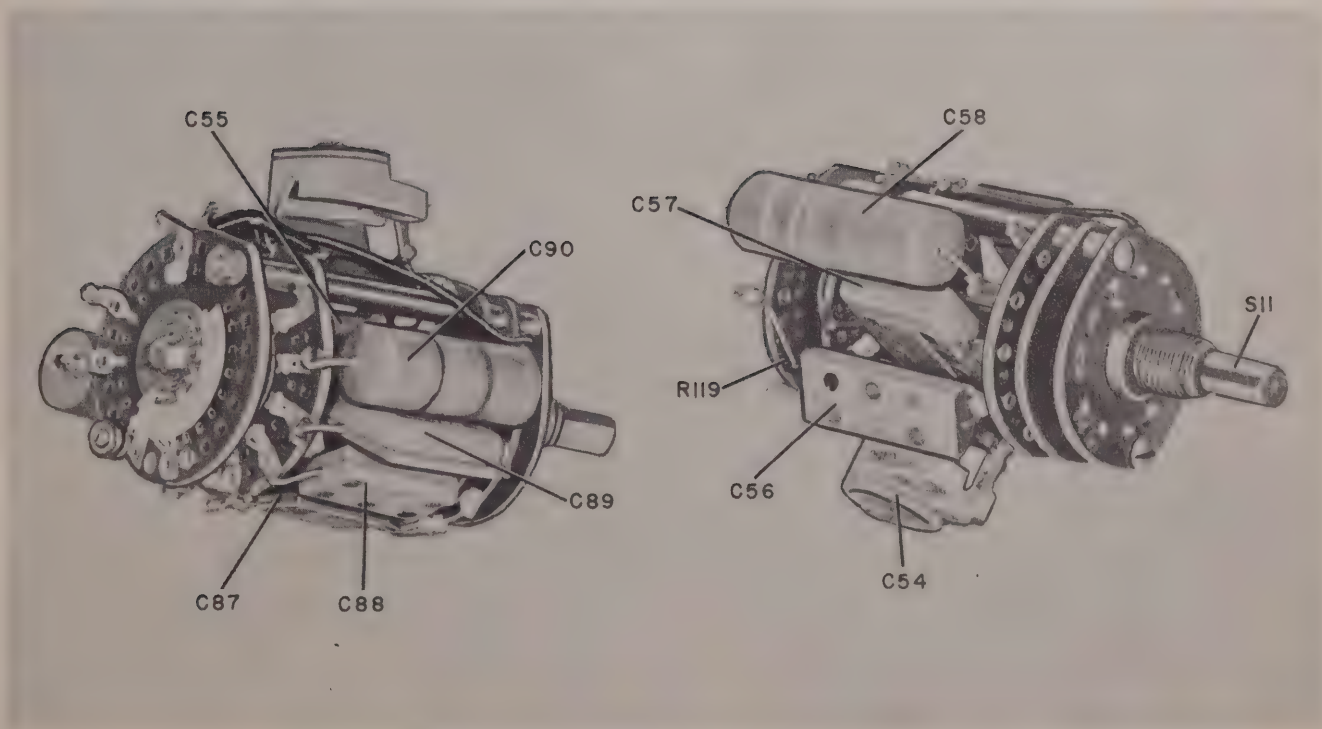


Figure 7—32. SWEEP RANGE, Assembly Z3

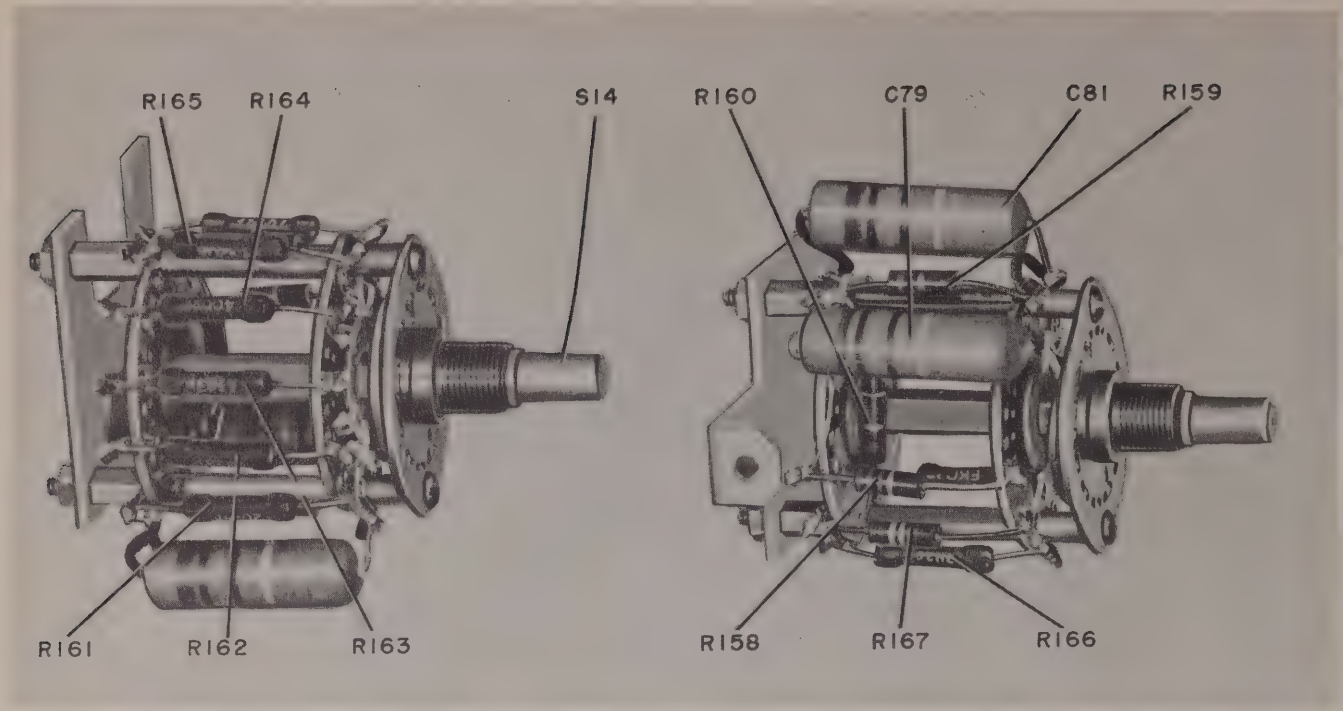


Figure 7—33. TRIGGER PPS, Assembly Z4

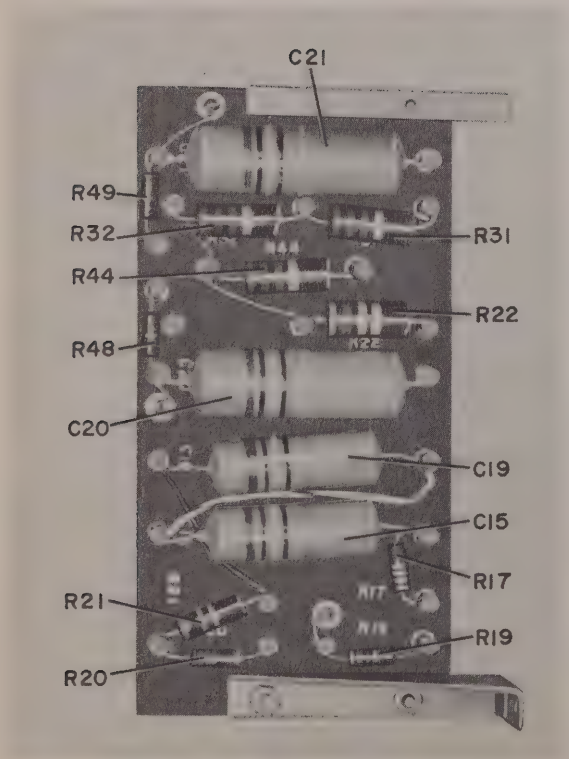


Figure 7—34. Terminal Board TB-2

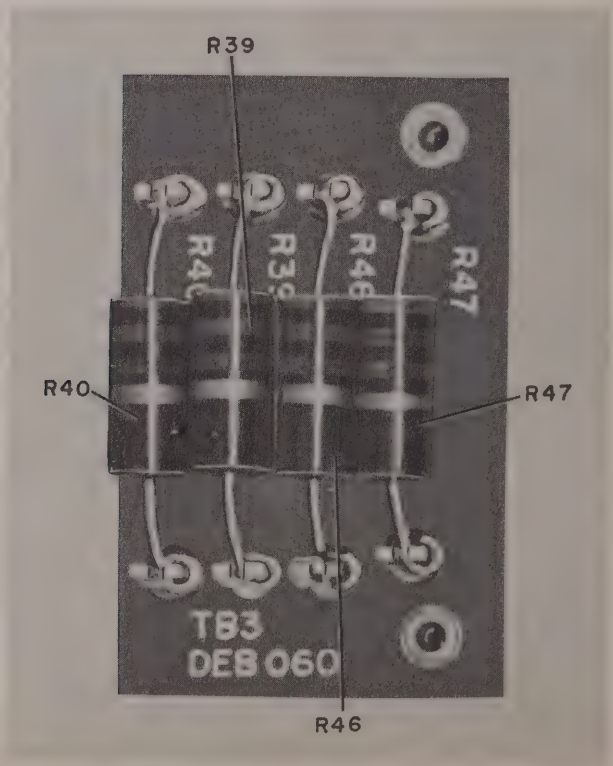


Figure 7—35. Terminal Board TB-3

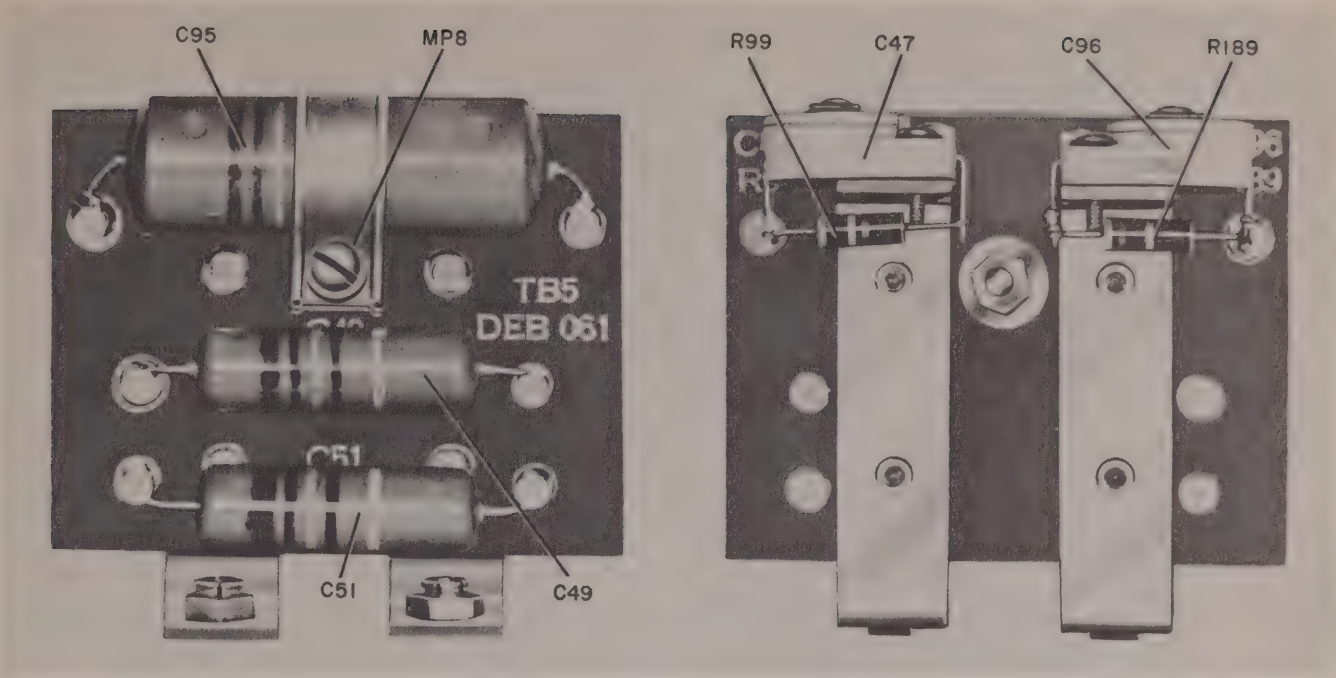


Figure 7—36. Terminal Board TB-5

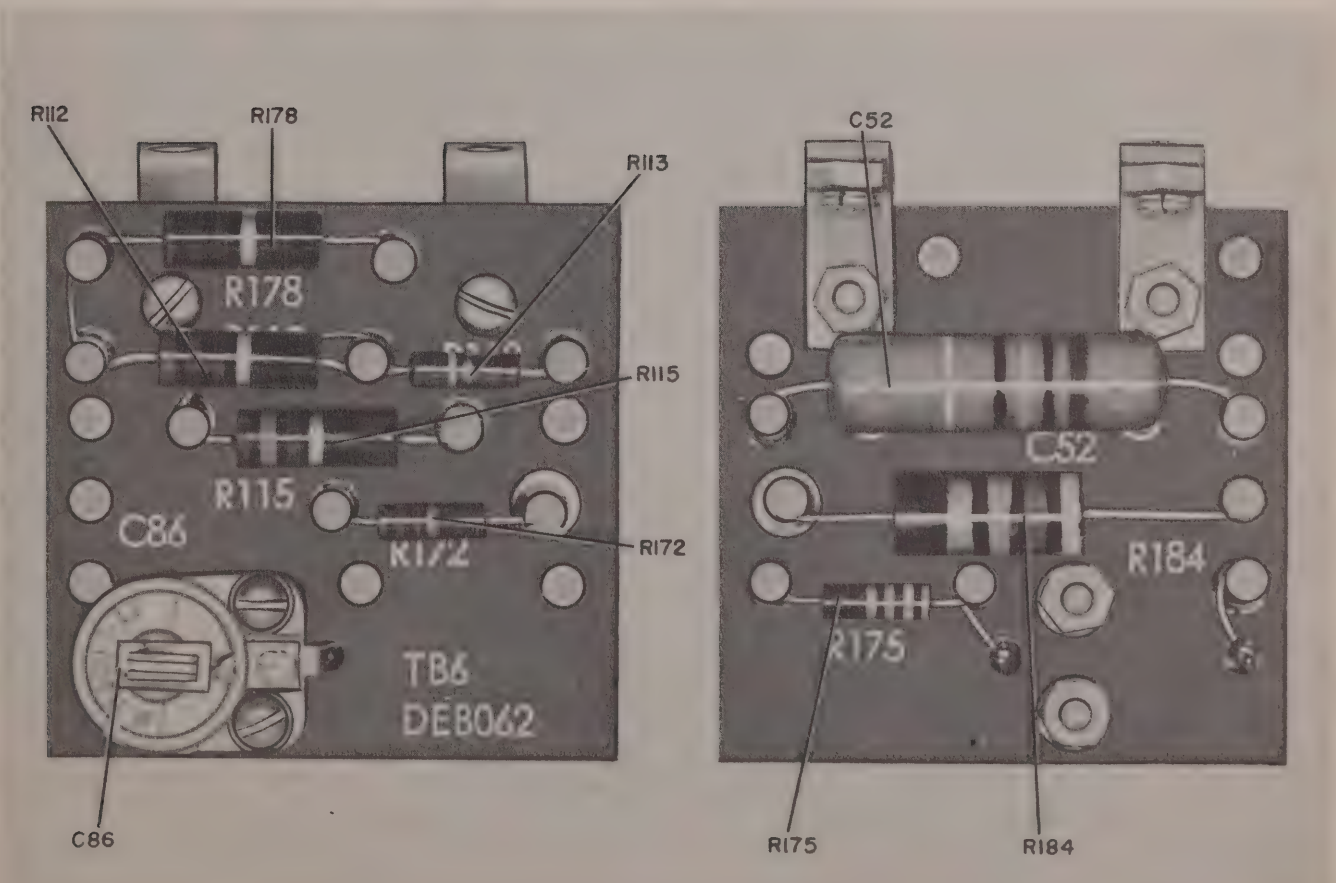


Figure 7—37. Terminal Board TB-6

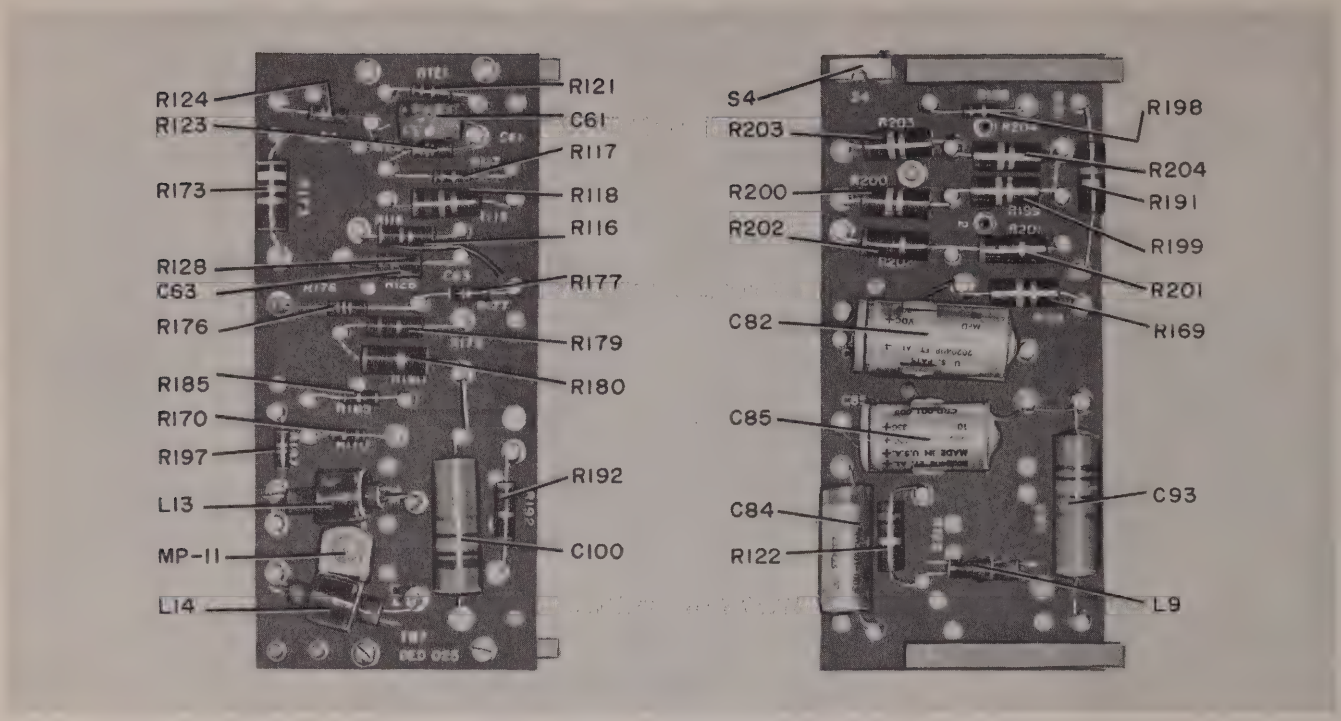


Figure 7—38. Terminal Board TB-7

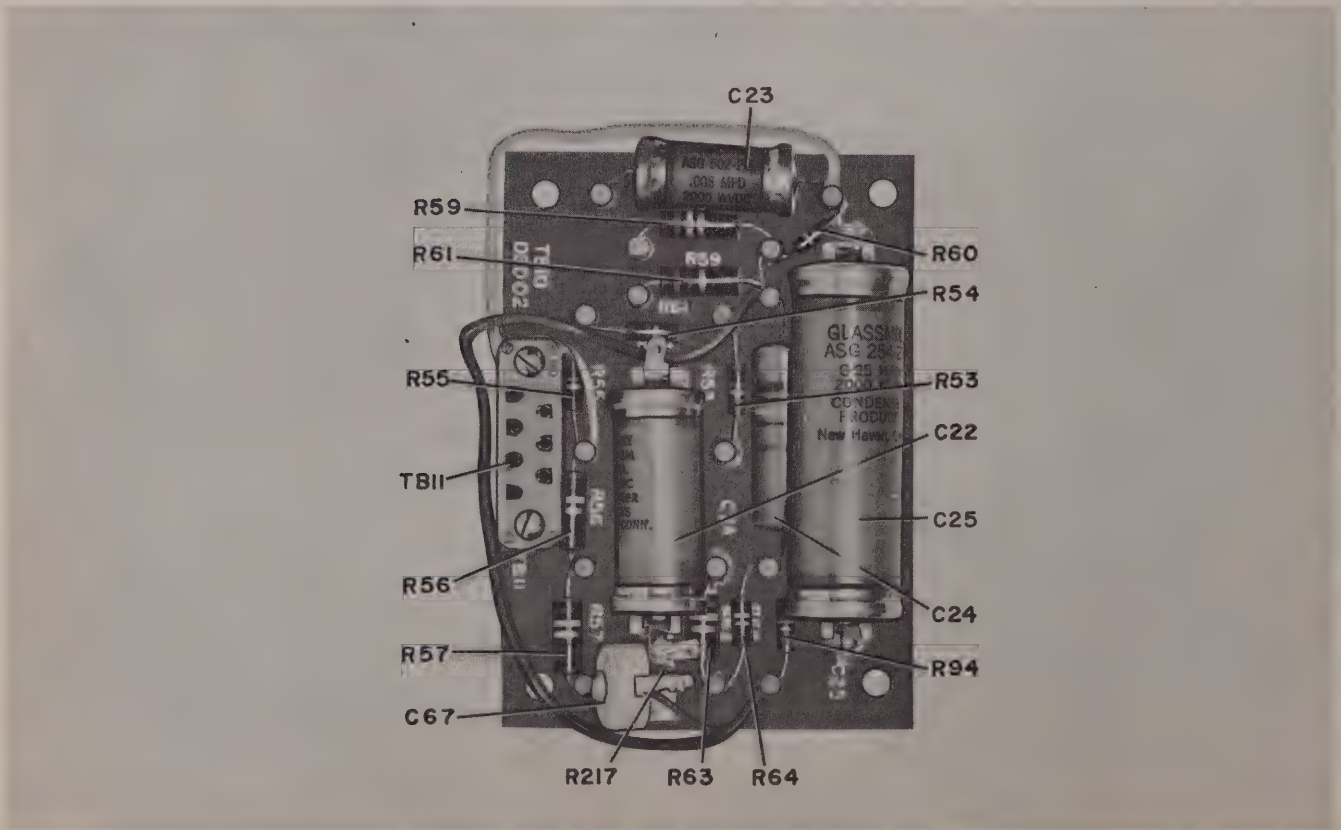


Figure 7—39. Terminal Board TB-10

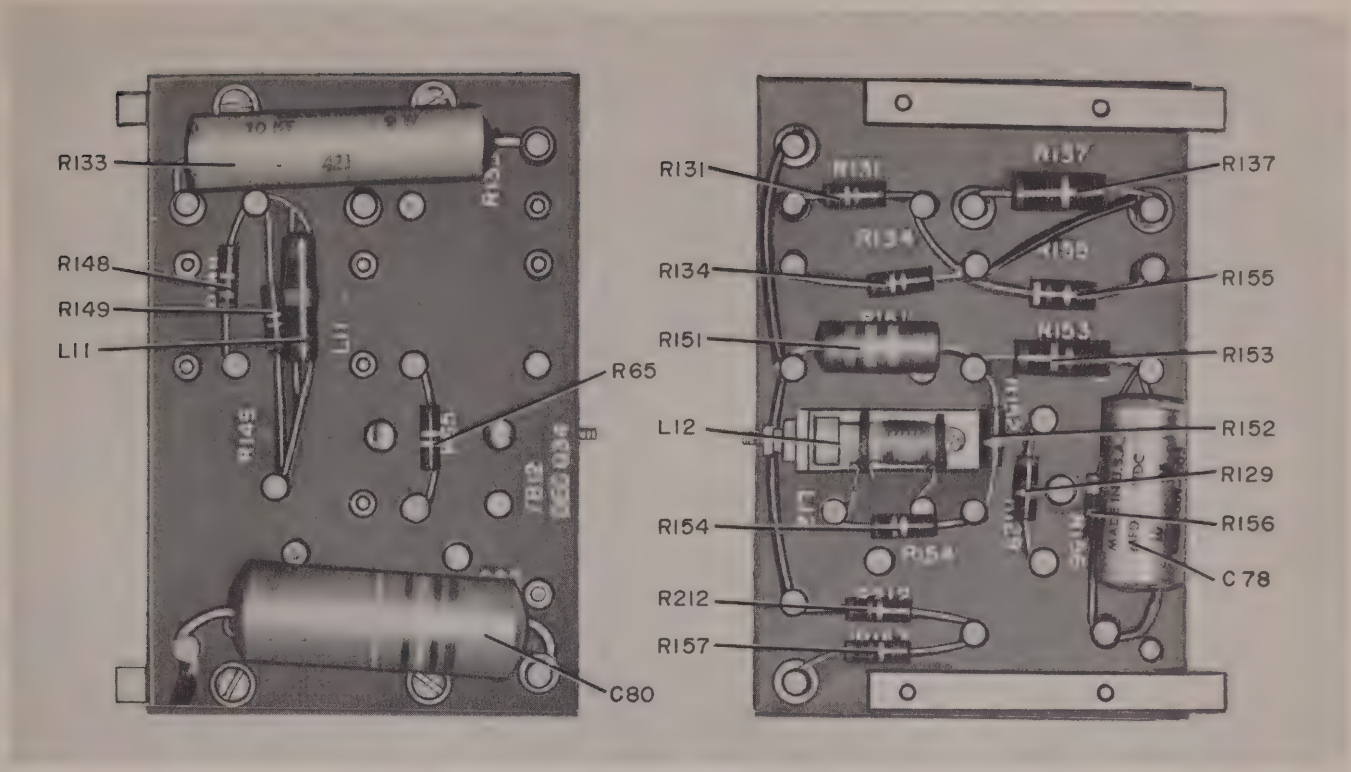


Figure 7—40. Terminal Board TB-12

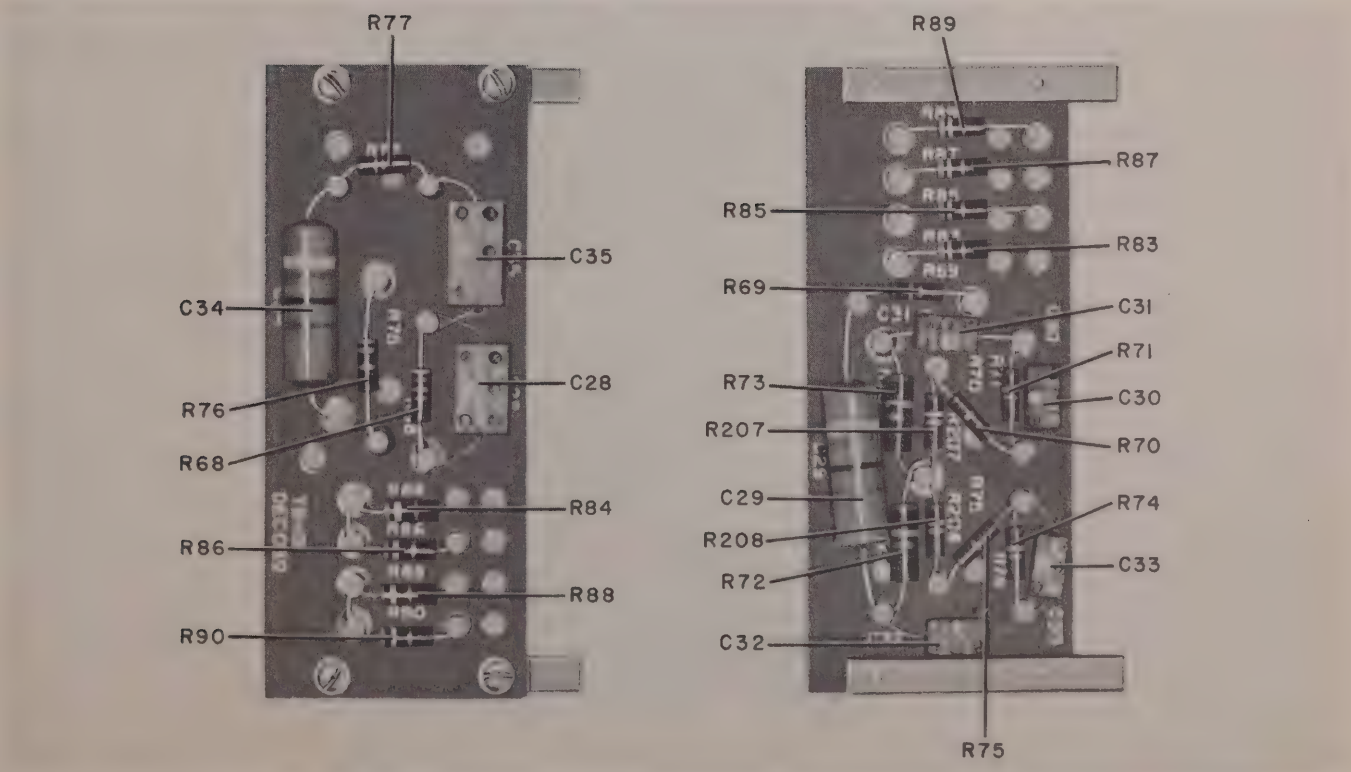


Figure 7—41. Terminal Board TB-13

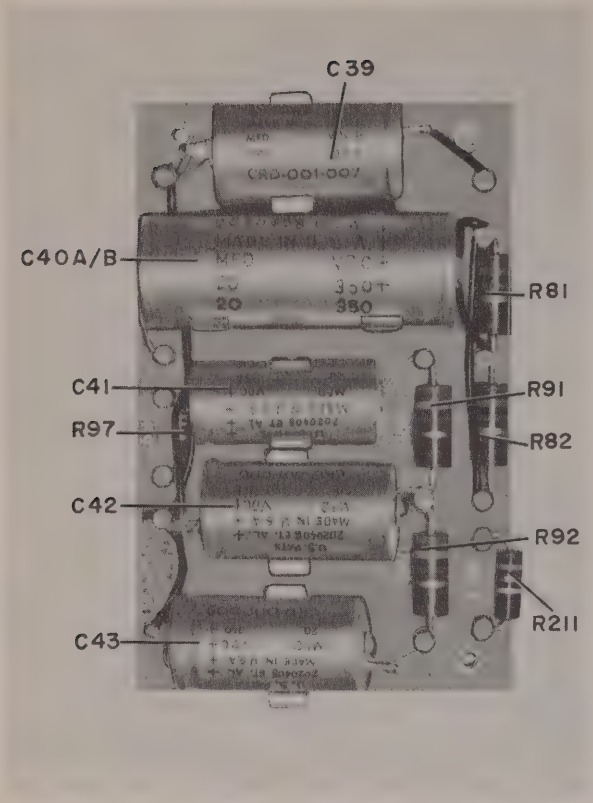


Figure 7—42. Terminal Board TB-14

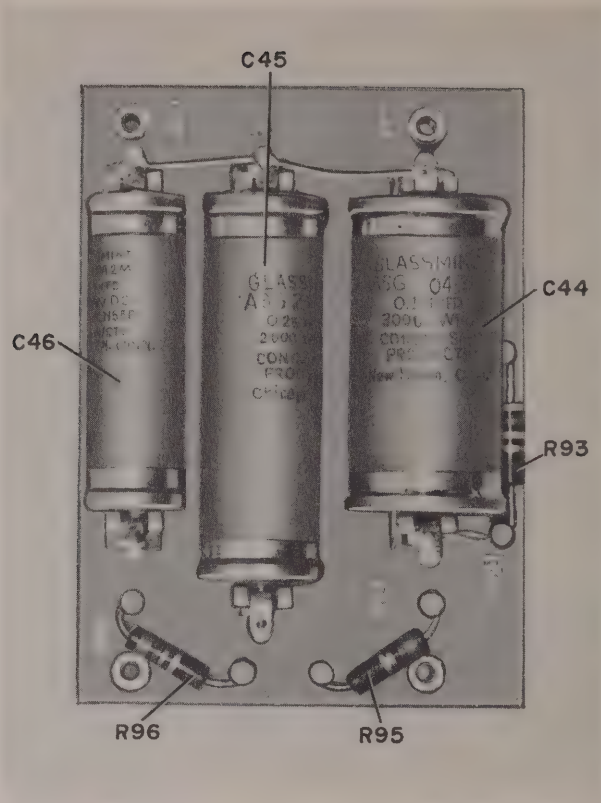


Figure 7—43. Terminal Board TB-15

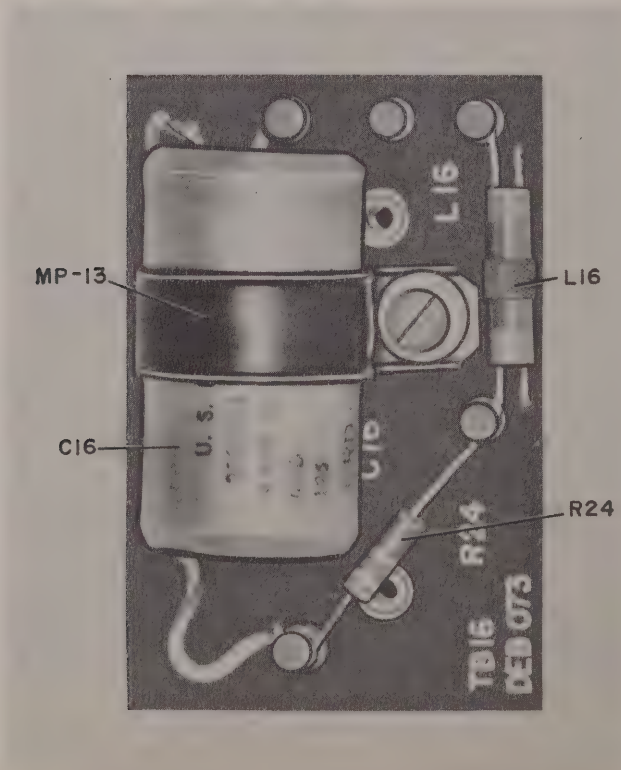


Figure 7—44. Terminal Board TB-16

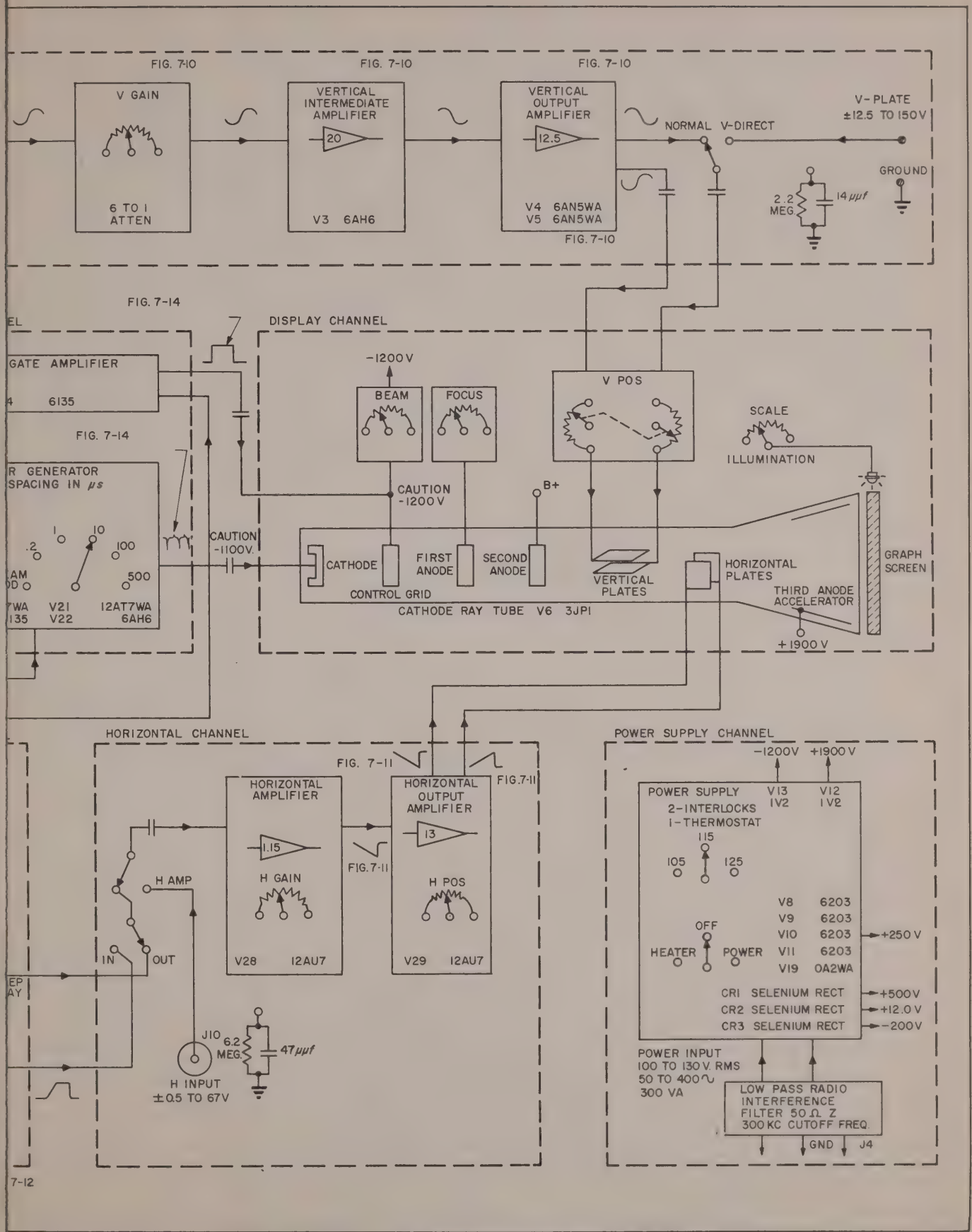


Figure 7—45. Oscilloscope OS-51/USM-24C, Block Diagram

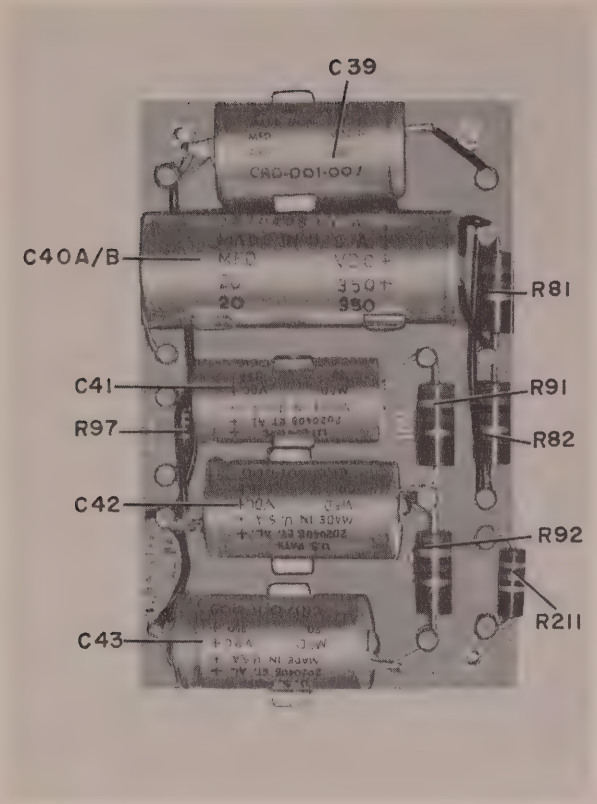


Figure 7—42. Terminal Board TB-14

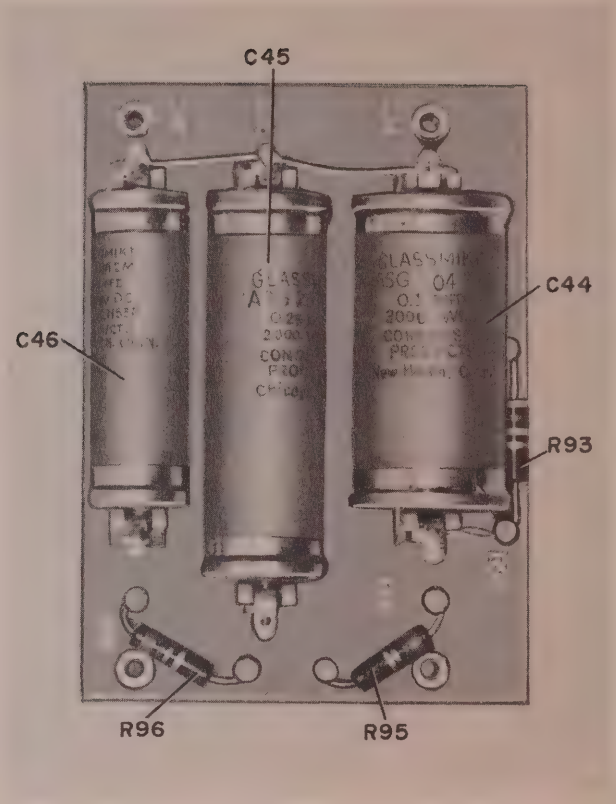


Figure 7—43. Terminal Board TB-15

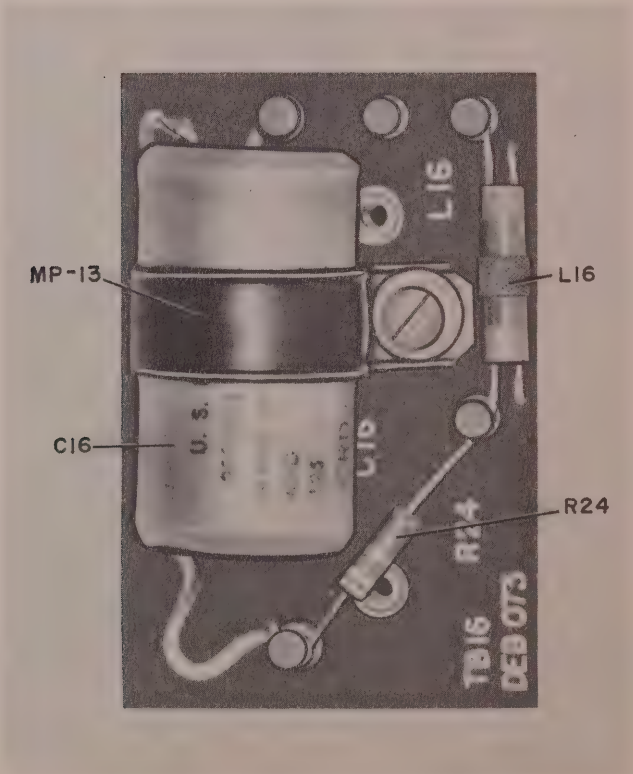


Figure 7—44. Terminal Board TB-16

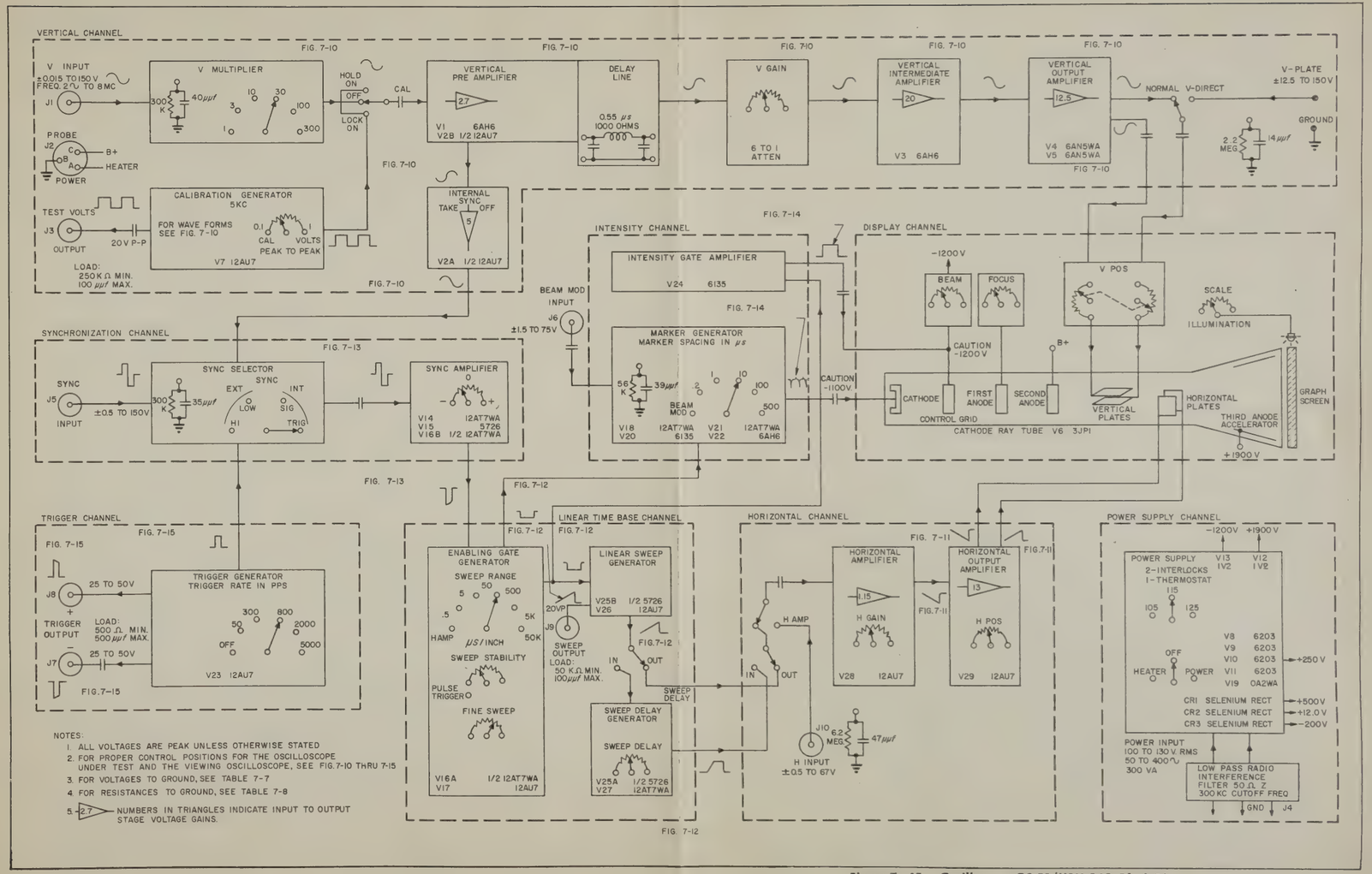
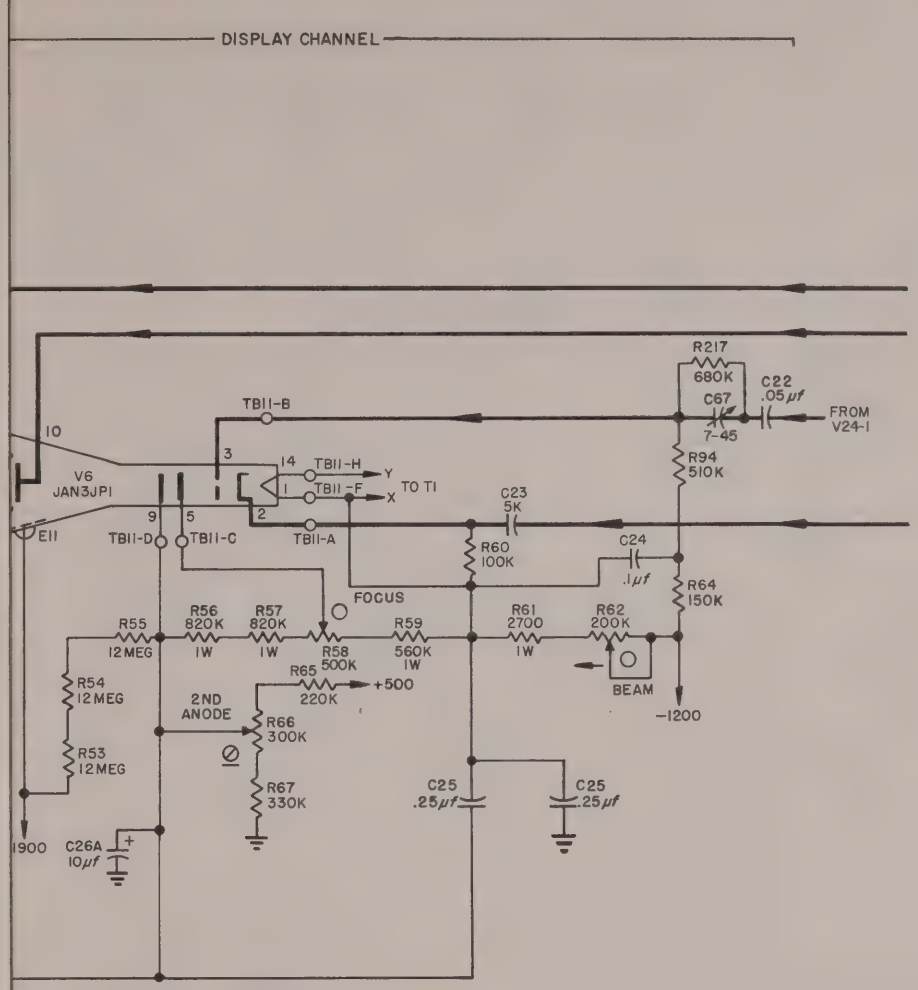


Figure 7—45. Oscilloscope OS-51/USM-24C, Block Diagram



ARE IN OHMS AND 1/2 WATT UNLESS OTHERWISE SPECIFIED.
ARE IN MICROMICROFARADS UNLESS OTHERWISE SPECIFIED.
000.
) 1,000,000.
IS C104 (OSCILLOSCOPE), C304 (ACCESSORIES)
IS R219 (OSCILLOSCOPE), R305 (ACCESSORIES)
S ARE SHOWN IN THE FOLLOWING OPERATING POSITIONS:
PLIER--- X1
-------- OFF
--------115V
--------INT SIGNAL
RANGE-----.5-5μs/INCH
μS------.2μs
PPS-----50
ELAY-----OUT

ANY VALUE BETWEEN 0 OHMS AND 270K OHMS.

E SECTIONS OF MULTIPLE ELECTROLYTIC CAPACITORS

Figure 7—46. (Sheet 1 of 2) Oscilloscope OS-51/USM-24C, Schematic Diagram

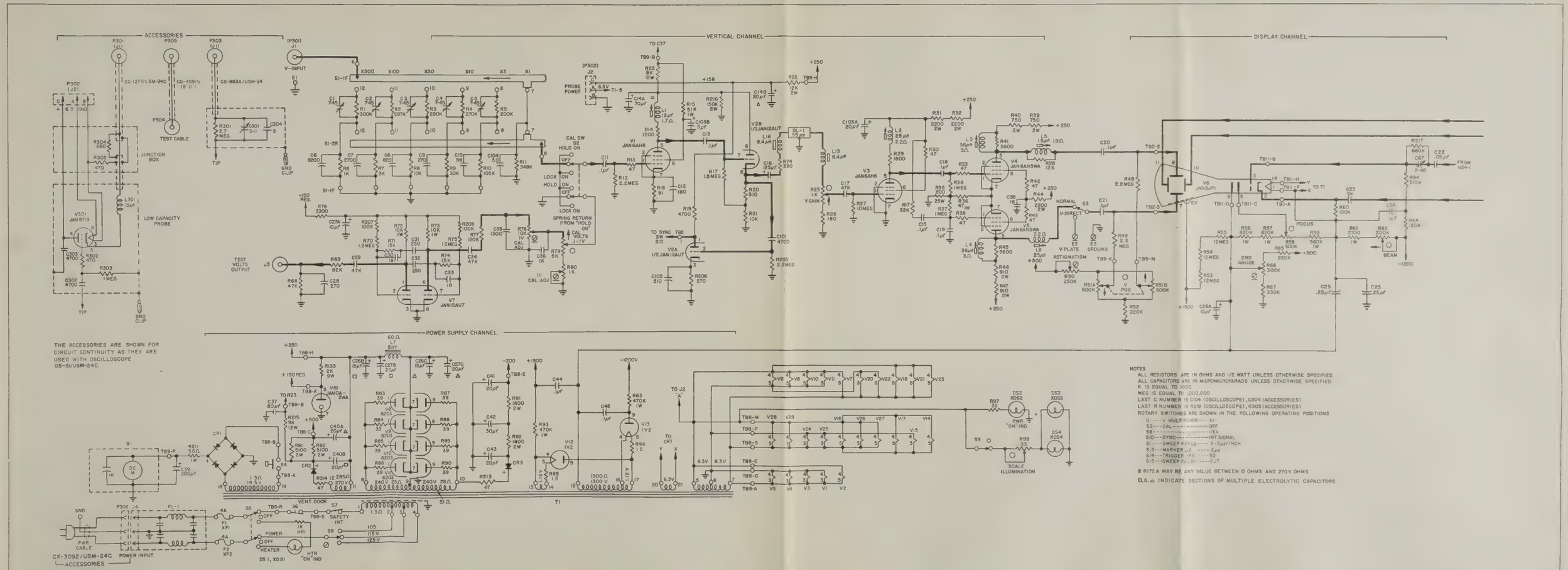


Figure 7–46. (Sheet 1 of 2) Oscilloscope OS-51/USM-24C, Schematic Diagram

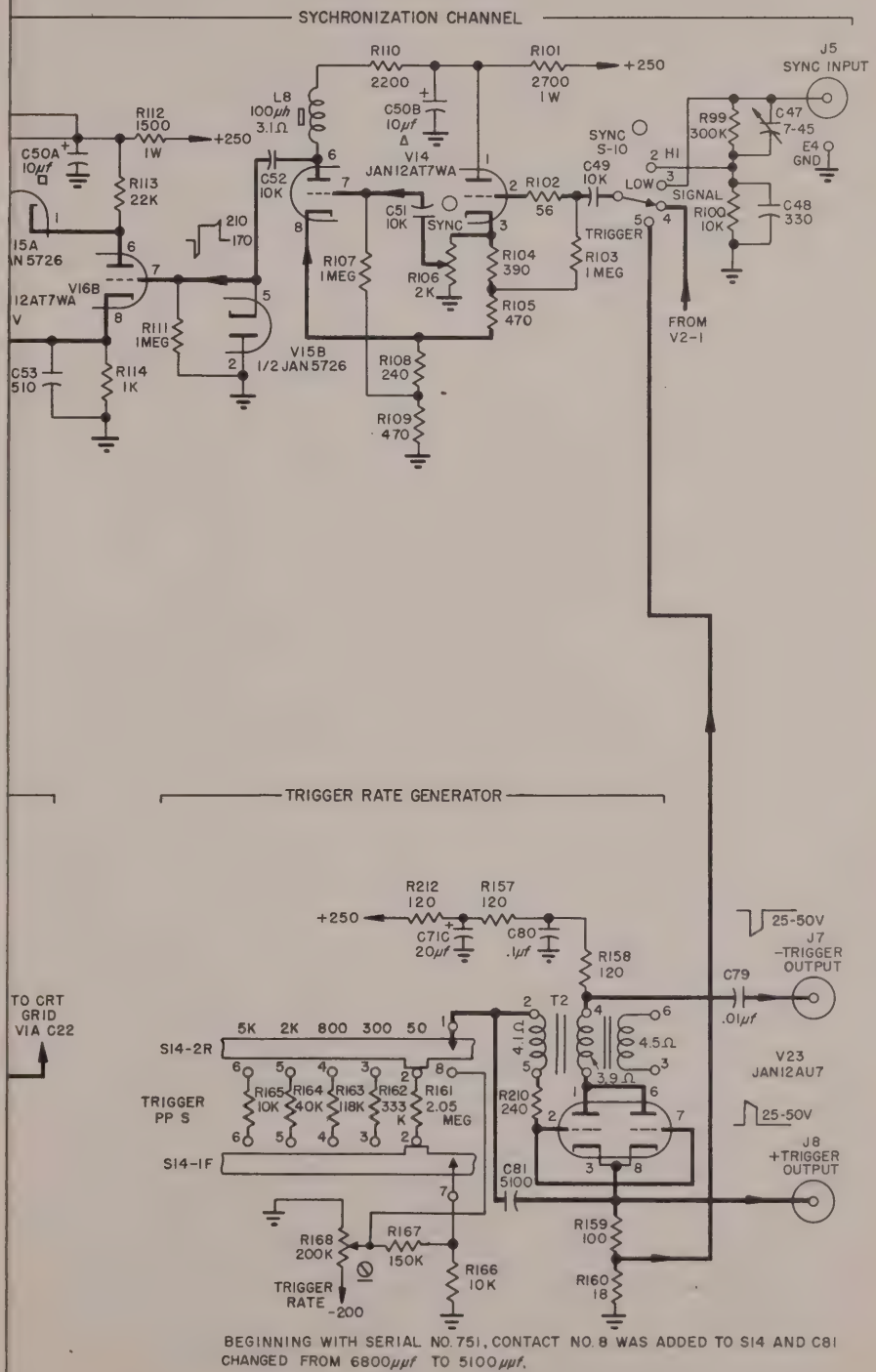


Figure 7—46. (Sheet 2 of 2) Oscilloscope OS-51/USM-24C, Schematic Diagram

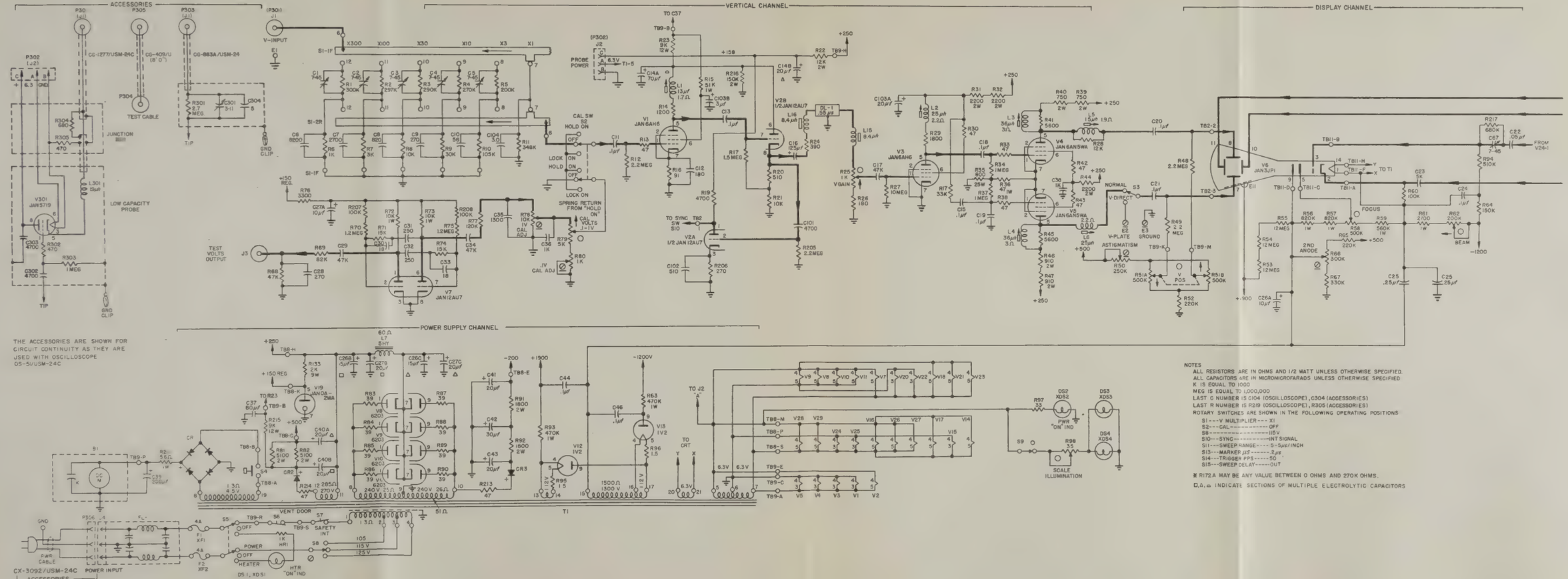


Fig. 7—46. (Sheet 1 of 2)

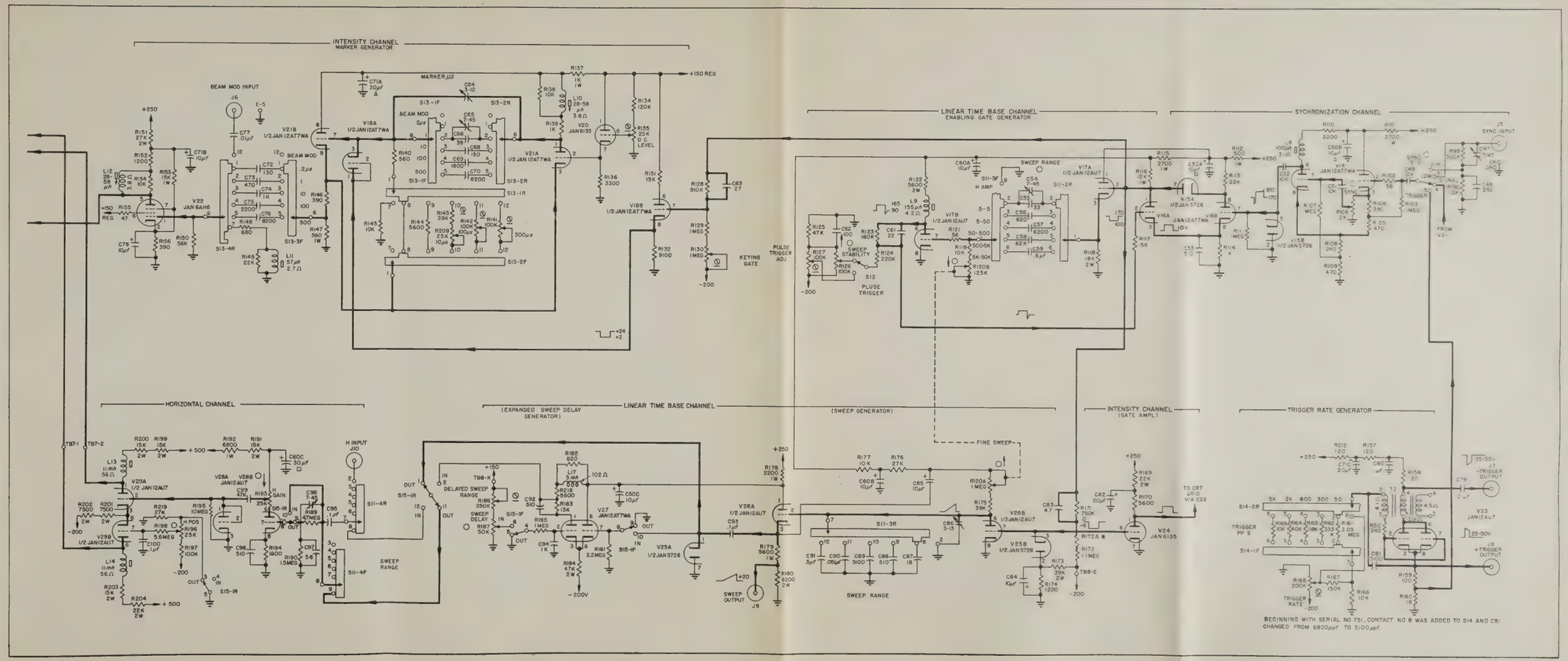


Figure 7—46. (Sheet 2 of 2) Oscilloscope OS-51/USM-24C, Schematic Diagram

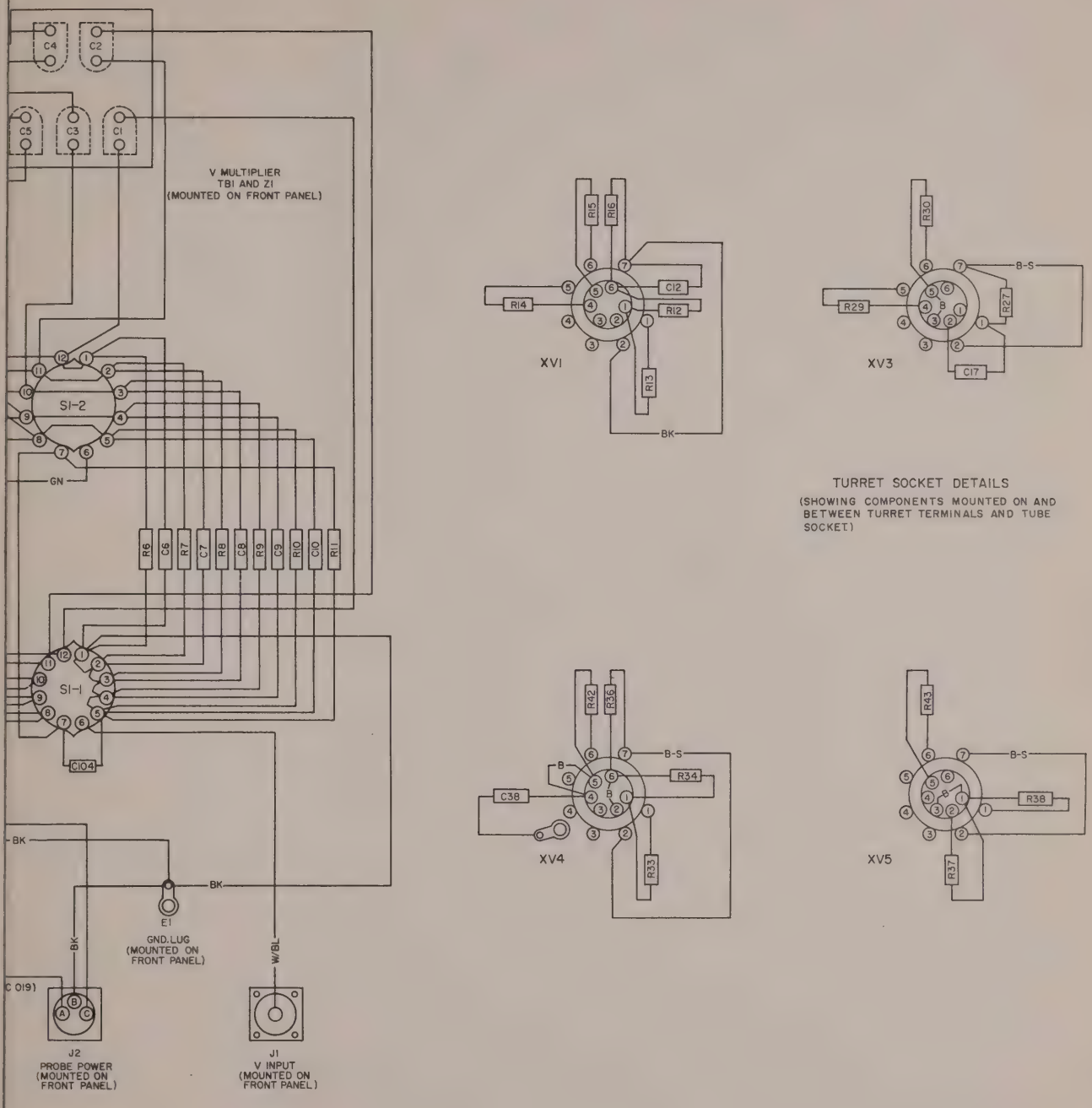


Figure 7—47. Wiring Diagram, Upper Left Hand Chassis

NOTES

1. CIRCLED NUMBERS INSIDE SWITCH WAFERS INDICATE TERMINALS ON FRONT OF WAFER. CIRCLED NUMBERS ON OUTER EDGE OF SWITCH WAFERS INDICATED TERMINALS ON REAR OF WAFER.
2. SWITCH TERMINALS ARE NUMBERED CLOCKWISE AS VIEWED FROM KNOB END OF SHAFT.
3. VARIABLE RESISTOR LUGS ARE NUMBERED CLOCKWISE AS VIEWED FROM REAR.
4. NUMBERS INSIDE TERMINALS ON TERMINAL BOARDS ARE FOR REFERENCE ONLY. THESE NUMBERS DO NOT APPEAR ON THE TERMINAL BOARD.
5. LETTER "U" DESIGNATES TUBE SOCKET UMBERLLA TERMINALS.
6. COLOR CODING

COLOR	CODE	COLOR	CODE
BLACK	BK	ORANGE	O
BLUE	BL	PURPLE	P
BROWN	BR	RED	R
GRAY	GY	WHITE	W
GREEN	GN	YELLOW	Y
BARE #22 AWG	B		
BLACK SLEEVING	S		
BARE WITH SLEEVING	B-S		

TRACER WIRE IS INDICATED BY A SLANT LINE (W/R INDICATES WHITE WIRE WITH RED TRACER).

7. ALL WIRES HAVE 7 STRANDS OF #30 AWG EXCEPT WHERE NOTED. W/BL (10) DENOTES 10 STRANDS OF #30 AWG. W/BL (16) DENOTES 16 STRANDS OF #30 AWG.

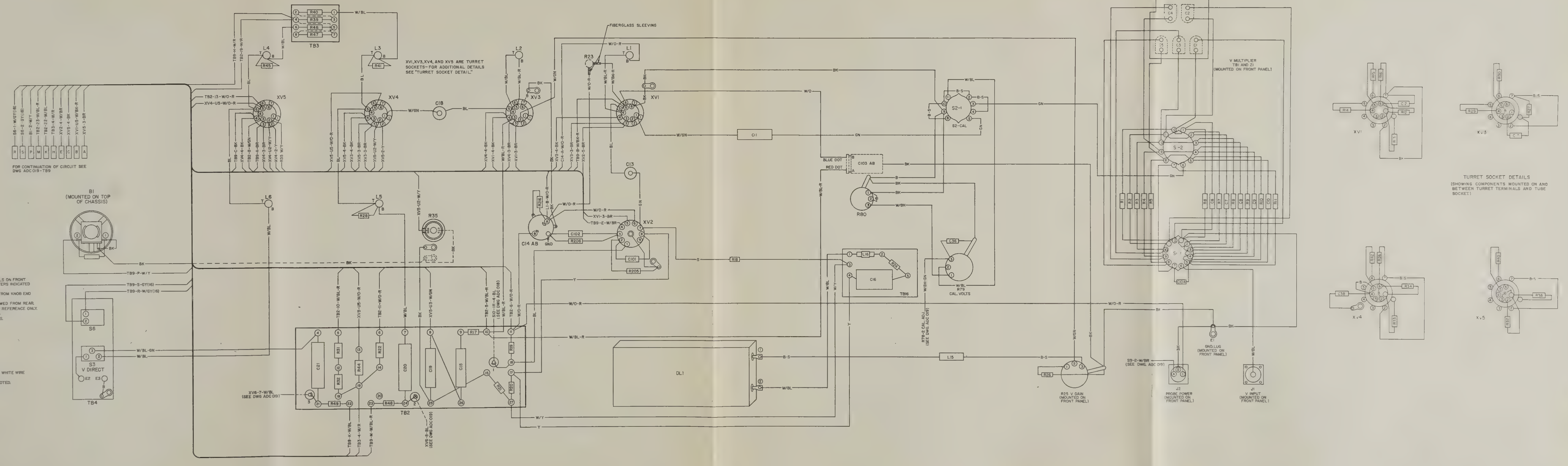


Figure 7—47. Wiring Diagram, Upper Left Hand Chassis

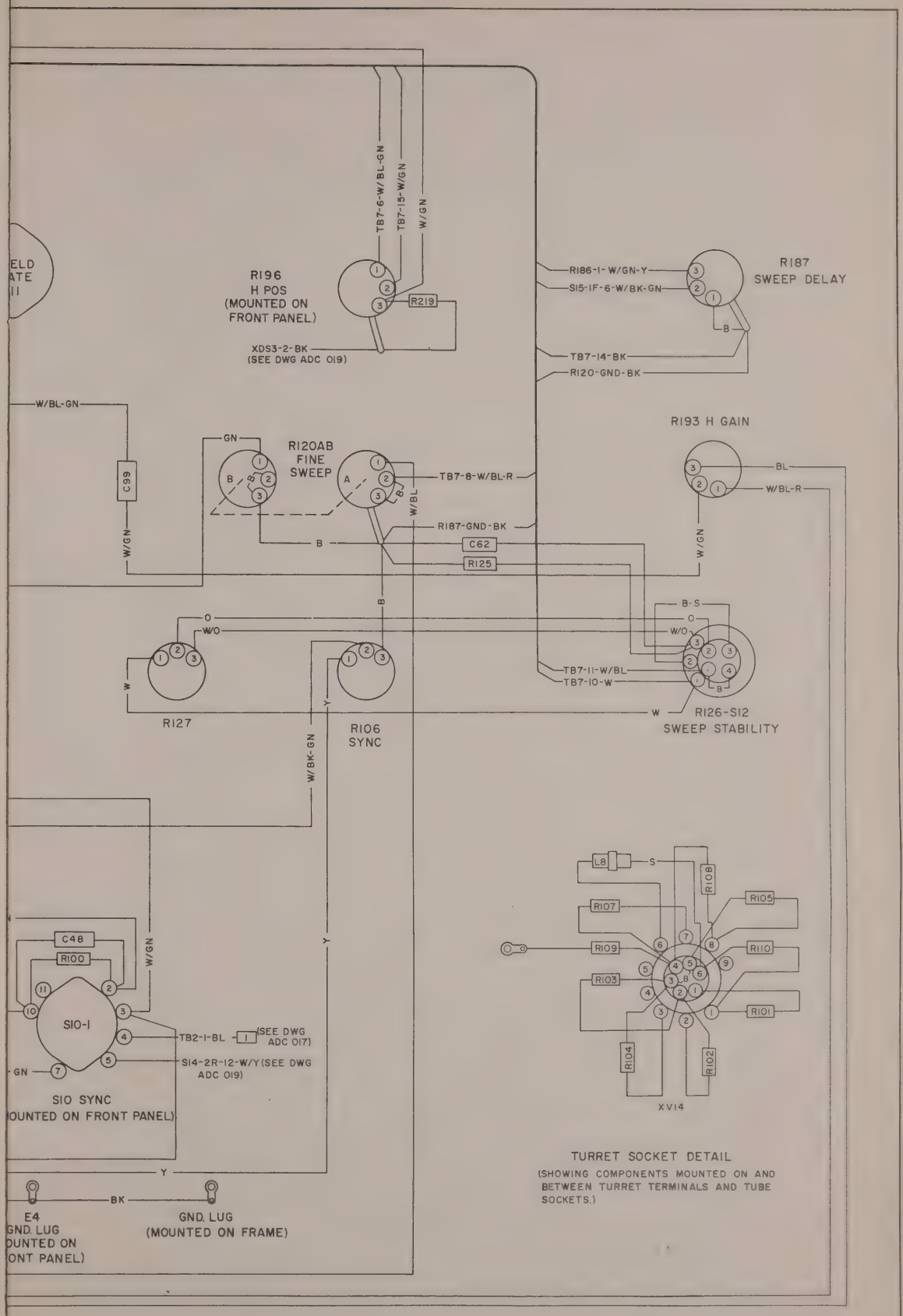


Figure 7—48. Wiring Diagram, Upper Right Hand Chassis

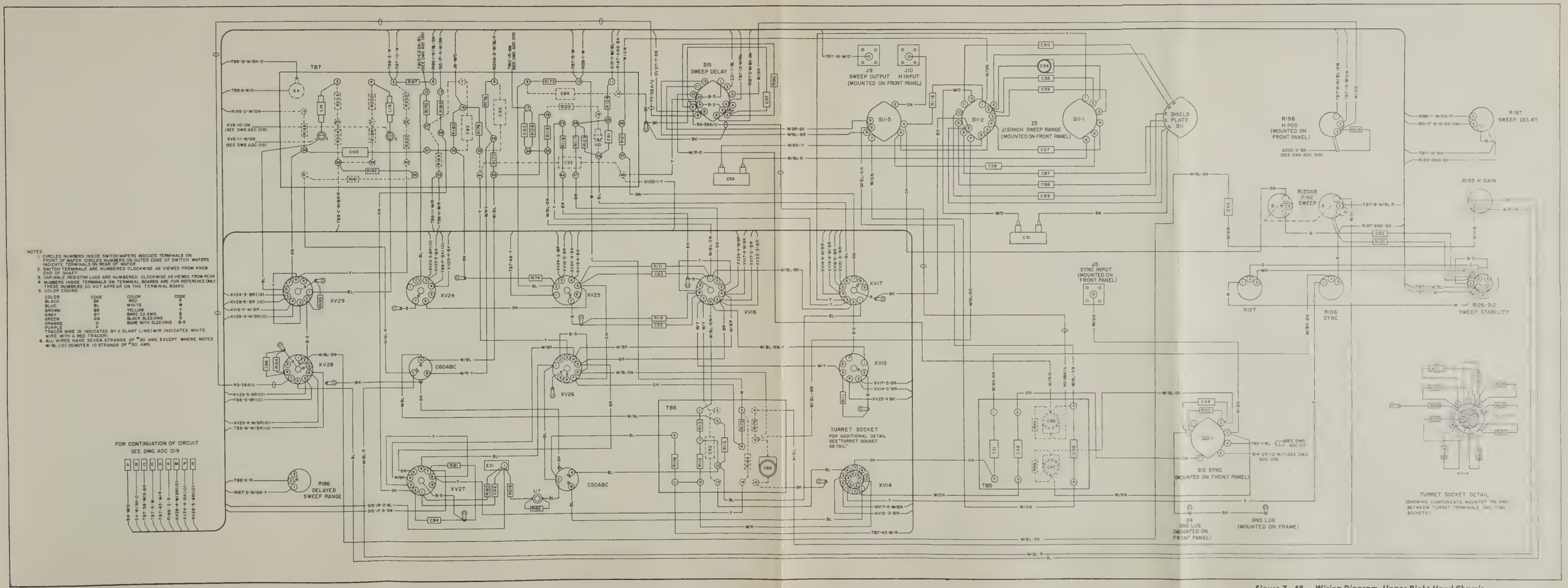
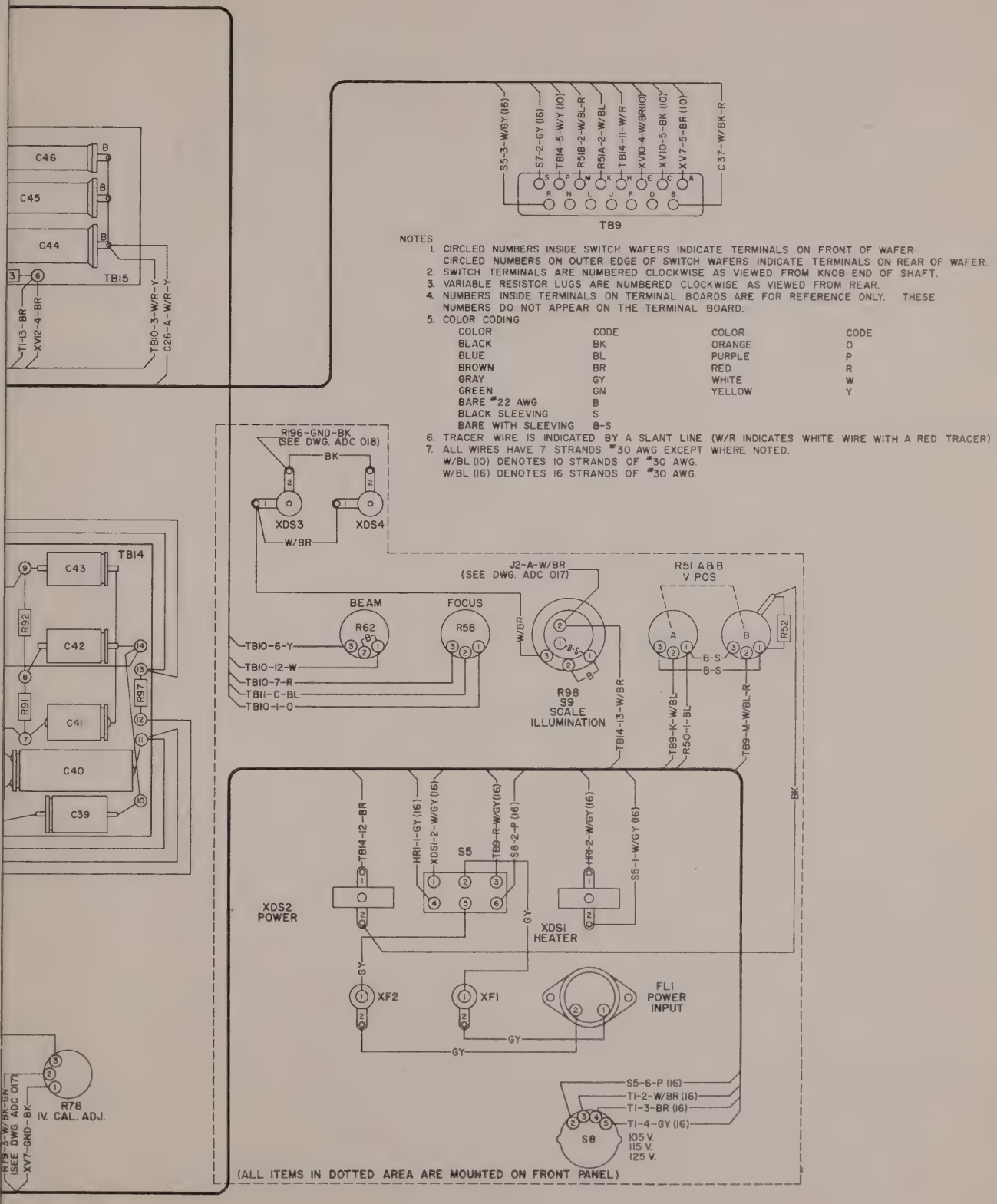


Figure 7—48. Wiring Diagram, Upper Right Hand Chassis



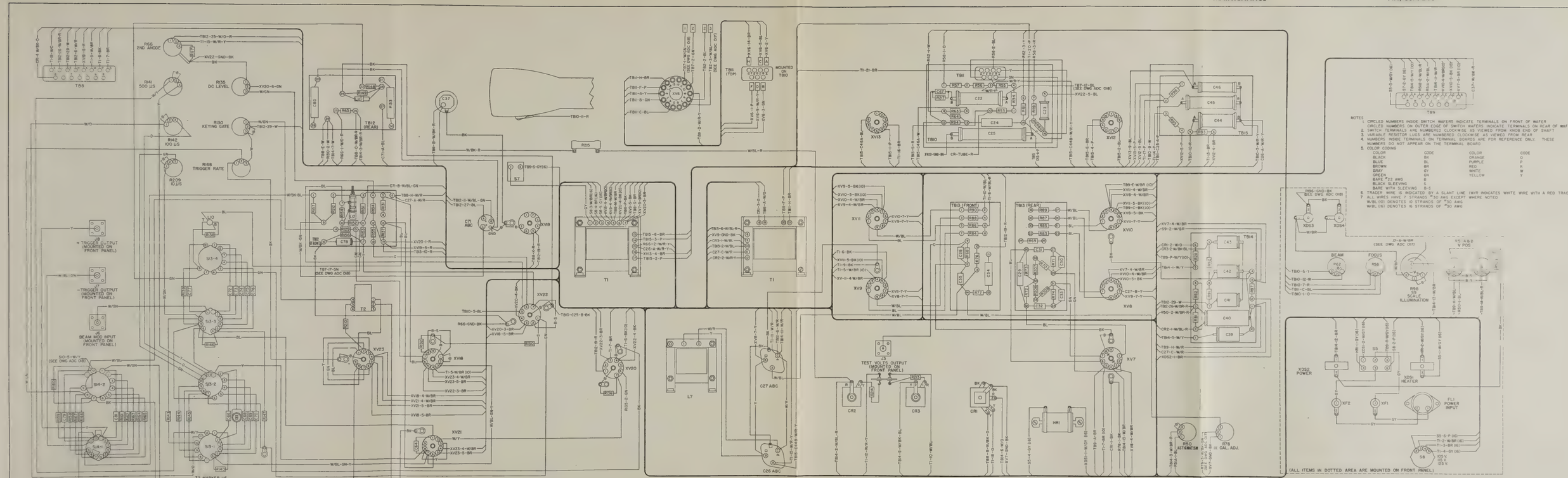
NOTES

1. CIRCLED NUMBERS INSIDE SWITCH WAFERS INDICATE TERMINALS ON FRONT OF WAFER. CIRCLED NUMBERS ON OUTER EDGE OF SWITCH WAFERS INDICATE TERMINALS ON REAR OF WAFER.
2. SWITCH TERMINALS ARE NUMBERED CLOCKWISE AS VIEWED FROM KNOB END OF SHAFT.
3. VARIABLE RESISTOR LUGS ARE NUMBERED CLOCKWISE AS VIEWED FROM REAR.
4. NUMBERS INSIDE TERMINALS ON TERMINAL BOARDS ARE FOR REFERENCE ONLY. THESE NUMBERS DO NOT APPEAR ON THE TERMINAL BOARD.
5. COLOR CODING

COLOR	CODE	COLOR	CODE
BLACK	BK	ORANGE	O
BLUE	BL	PURPLE	P
BROWN	BR	RED	R
GRAY	GY	WHITE	W
GREEN	GN	YELLOW	Y
BARE #22 AWG	B		
BLACK SLEEVING	S		
BARE WITH SLEEVING	B-S		

6. TRACER WIRE IS INDICATED BY A SLANT LINE (W/R INDICATES WHITE WIRE WITH A RED TRACER)
7. ALL WIRES HAVE 7 STRANDS #30 AWG EXCEPT WHERE NOTED.
   W/BL (10) DENOTES 10 STRANDS OF #30 AWG.
   W/BL (16) DENOTES 16 STRANDS OF #30 AWG.

Figure 7—49. Wiring Diagram, Lower Chassis



NOTES:
1. CIRCLED NUMBERS INSIDE SWITCH WAFERS INDICATE TERMINALS ON FRONT OF WAFER. CIRCLED NUMBERS ON OUTER EDGE OF SWITCH WAFERS INDICATE TERMINALS ON REAR OF WAFER
2. SWITCH TERMINALS ARE NUMBERED CLOCKWISE AS VIEWED FROM KNOB END OF SHAFT
3. VARIABLE RESISTOR LUGS ARE NUMBERED CLOCKWISE AS VIEWED FROM REAR
4. NUMBERS INSIDE TERMINALS ON TERMINAL BOARDS ARE FOR REFERENCE ONLY. THESE NUMBERS DO NOT APPEAR ON THE TERMINAL BOARD
5. COLOR CODING

COLOR	CODE	COLOR	CODE
BLACK	BK	ORANGE	O
BLUE	BL	PURPLE	P
BROWN	BR	RED	R
GRAY	GY	WHITE	W
GREEN	GN	YELLOW	Y
BARE #22 AWG	B		
BLACK SLEEVING	S		
BARE WITH SLEEVING	B-S		

6. TRACER WIRE IS INDICATED BY A SLANT LINE (W/R INDICATES WHITE WIRE WITH A RED TRACER)
7. ALL WIRES HAVE 7 STRANDS #30 AWG EXCEPT WHERE NOTED
   W/BL (10) DENOTES 10 STRANDS OF #30 AWG
   W/BL (16) DENOTES 16 STRANDS OF #30 AWG

Figure 7—49. Wiring Diagram, Lower Chassis

SECTION 8
PARTS LIST

1. INTRODUCTION.

Reference designations (previously referred to as circuit symbol, reference symbol, etc.) have been assigned to identify all maintenance parts of the equipment. They are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams and the parts list. *The letters* of a reference designation indicate the kind of part (generic group) such as resistor, amplifier, electron tube, etc. *The number* differentiates between parts of the same generic group. Parts of the first major unit are numbered from 1 to 199; parts of the second 201 to 299, etc. Two consecutive series of numbers have been assigned to major units in which there are more than one hundred parts of the same generic group. Sockets associated with a particular plug-in device such as an electron tube or a fuse are identified by a reference designation which includes the reference designation of the plug-in device. For example, the socket for fuse F7 is designated XF7.

2. MAINTENANCE PARTS LISTS.

Table 8—1 lists all major units and their maintenance parts. Each major unit's parts are grouped together.

Column 1 lists the reference series of the various parts in alphabetical and numerical sequence.

Column 2 includes a reference to the explanatory notes that appear at the front of the table.

Column 3 includes the name and description of the various items. Information classified higher than the parts list have been omitted. Complete information is provided for all key parts (a part previously listed in the table) and sub-key parts (a part that is identical to a key part, but appears for the first time for a given major unit). The name and description is omitted for other parts. However, reference is made to the key part or sub-key part of the data.

Column 4 indicates how the part is used and provides its functional location in the equipment.

3. PARTS SUPPLIED WITH EQUIPMENT.

Table 8-2 gives a list of maintenance parts supplied as a permanent part of the equipment. The items should be replaced as soon as they are used.

4. STOCK NUMBER IDENTIFICATION.

Table 8-3 gives stock numbers for the various items. Stock numbers preceded by an asterisk apply to replacement items which differ from the items supplied in the equipment.

5. LIST OF MANUFACTURERS.

Table 8-4 lists manufacturers of parts used in the equipment. The prefix letters are those assigned by the Bureau of Ships to identify the manufacturers, on identification plates (name plates) and on small parts.

6. NOTES.

The following provide additional information about items listed in Table 8—1.

1. Low failure items—if required requisition from ESO, referencing Navships 900, 180A.
2. Shop manufacture.
3. For reference only.
4. Replace with the substitute part having the stock number listed in Table 8—3.
5. Assemble from component parts.

TABLE 8—1. MAINTENANCE PARTS LIST

NOTE

The symbol numbers under 300 are a part of OS-51/USM-24C. All numbers 300 and above are parts of accessories.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
A-1	1	FOOT, Mounting, Rubber, round, recessed, coined locking end, shoulder cut top, rubber molded to steel insert, recessed center hole, 3/8 lg x 27/64 in dia, insert hole 7/16 lg x 0.238 in dia, 13/16 lg x 1 15/16 in dia O/A, 3/16 in shoulder thickness, WPD Part No. INB-005-001, P/O CAGX Oscilloscope OS-51/USM-24C	Shock absorption. Prevents marring of case and supporting surface
A-2		Same as A-1	Shock absorption. Prevents marring of case and supporting surface
A-3		Same as A-1	Shock absorption. Prevents marring of case and supporting surface
A-4		Same as A-1	Shock absorption. Prevents marring of case and supporting surface
A-5		Not used	
A-6		Not used	
A-7		CASE, Combination, alum, gray enamel fin, 15 in high x 17 3/8 in wide x 12 1/4 in deep, two carrying handles one on each side, 4 cover clasps, two each on top and one on each side, ventilation door with catch and water seal on rear, WPD Part No. DMD058-A01, P/O CAGX Oscilloscope OS-51/USM-24C	Oscilloscope housing less cover
B-1		BLOWER MOTOR ASSEMBLY, Min perm magnetic DC motor, with fan blade, fan housing and RF filter capacitor, 1000 uuf ±10%, 500 VDCW, motor rated at 12 VDC, 0.260 amp, .0016 HP, 8000 RPM, CW, when operated at 12.0 VDC with fan load, single shaft, .1200 in dia, 1/2 in long, motor dim 2 1/32 lg x 1 1/32 in wide x 1 3/32 in high, overall dim 2 7/8 long x 2 5/8 wide x 2 5/8 in high, two solder lug terminals, shock absorbing mtg on flange of fan housing, four mtg holes for No. 6 screw, 2 in mtg centers, WPD Part No. DEB067-A01, P/O CAGX Oscilloscope OS-51/USM-24C	Ventilation fan
B-1A	1	IMPELLAR, Fan, axial, alum, four blade, hub bore 0.120-0.125, two set screws 8-32 90° apart, overall dia 2 in, WPD Part No. DMA-047-001, P/O Blower assy, WPD Part No. DEB067-A01	P/O Blower motor assembly B-1
B-1B	1	HOUSING, Blower, Assembly, steel, c/o flange, tubing support, bracket, motor lower, bracket, motor upper, finish gray enamel, flange 4 3/8 in mtg holes 2 1/32 in centers, WPD Part No. DMB168-A01, P/O Blower assy, WPD Part No. DEB067-A01	P/O Blower motor assembly B-1
B-1C	1	MOTOR, DC, 12 volts, 260 MA, 0.0016 HP, torque 0.2 in oz, single take off, 8000 rpm, clockwise rot, 2.041/2.021 in lg x 1.207/1.157 wide x 1.207/1.157 high, round shaft 0.120/0.1195 in dia x 0.515/0.485 in lg, 2 solder lug term, 3 mtg holes No. 4-48NF-2B thread, PD 0.0985/0.1016, 0.188 useful mtg depth, DAB Part No. 5095000, WPD Part No. EKM002-001, P/O WPD Part No. DEB067-A01	P/O Blower motor assembly B-1
C-1		CAPACITOR, Variable, ceramic dielectric, rotary type, 7 to 45 uuf, 500 VDCW, JAN CV11C450, spec JAN-C-81, P/O TB-1 on Z-1	Capacitive element of series arm for the 300 multiplier step of the V MULTIPLIER switch
C-2		Same as C-1, P/O TB-1 on Z-1	Capacitive element of series arm for the 100 multiplier step of the V MULTIPLIER switch

Note: 1. Low Failure Items—If required requisition from ESO, referencing NAVSHIPS 900, 180A

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C-3		Same as C-1, P/O TB-1 on Z-1	Capacitive element of series arm for the 30 multiplier step of the V MULTIPLIER switch
C-4		Same as C-1, P/O TB-1 on Z-1	Capacitive element of series arm for the 10 multiplier step of the V MULTIPLIER switch
C-5		Same as C-1, P/O TB-1 on Z-1	Capacitive element of series arm for the 3 multiplier step of the V MULTIPLIER switch
C-6		CAPACITOR, Fixed, Mica Dielectric, 8200 uuf ±5%, 300 VDCW, JAN CM35C822J, spec MIL-C-5, P/O Z-1	Capacitive element of the shunt arm for the 300 multiplier step of the V MULTIPLIER switch
C-7		CAPACITOR, Fixed, Mica Dielectric, 2700 uuf ±5%, 500 VDCW, JAN CM30B272J, spec MIL-C-5, P/O Z-1	Capacitive element of the shunt arm for the 100 multiplier step of the V MULTIPLIER switch
C-8		CAPACITOR, Fixed, Mica Dielectric, 820 uuf ±5%, 500 VDCW, JAN CM30B821J, spec MIL-C-5, P/O Z-1	Capacitive element of the shunt arm for the 30 multiplier step of the V MULTIPLIER switch
C-9		CAPACITOR, Fixed, Mica Dielectric, 270 uuf ±5%, 500 VDCW, JAN CM20B271J, spec MIL-C-5, P/O Z-1	Capacitive element of the shunt arm for the 10 multiplier step of the V MULTIPLIER switch
C-10		CAPACITOR, Fixed, Mica Dielectric, 56 uuf ±5%, 500 VDCW, JAN CM20B560J, spec MIL-C-5, P/O Z-1	Capacitive element of the shunt arm for the 3 multiplier step of the V MULTIPLIER switch
C-11	4	CAPACITOR, Fixed, Paper Dielectric, 100,000 uuf ±20%, 400 VDCW, plastic case, hermetically sealed, 1⅞ in lg x ⅝ in dia, 2 axial leads, SPR type 106P, WPD Part No. CPB006-009	Couples V MULTIPLIER to V-1
C-12	4	CAPACITOR, Fixed, Mica Dielectric, 180 uuf ±5%, 300 VDCW, JAN CM15B181J, spec MIL-C-5	High frequency cathode peaking for V-1
C-13		CAPACITOR, Assembly and Sleeve, Fixed, Paper Dielectric, 100,000 uuf ±20%, 400 VDCW, WPD Part No. DEB068-A01	Couples V-1 plate to V-2B grid
C-14A, B		CAPACITOR, Fixed, Electrolytic, 2 sect sect (a) 350 VDCW, 70 uf, −10% to +100% tol, sect (b) 350 VDCW, 20 uf, −10% to +100% tol, −40 deg C to +85 deg C working temp range, tub metal case not insulated, 2½ in long x 1⅜ in dia, MAL type WP, WPD Part No. CDE002-012	Decouples V-1, V-2 and PROBE POWER from power supply
C-15		CAPACITOR, Fixed, Paper Dielectric, 200 VDCW, 100,000 uuf ±20%, plastic case, hermetically sealed, 1½ in long x ½ in dia, 2 axial leads, SPR type 106P, WPD Part No. CPB006-003, P/O TB-2	Part of decoupling network for grid of V-5
C-16		CAPACITOR, Fixed, Electrolytic, 50 VDCW, 125 uf, −10% to +100% tol, −40 deg C to +85 deg C working temp range, tubular metal case with vinyl insulating sleeve, 1⁹⁄₁₆ in long x ⅞ in dia, MAL type TA, WPD Part No. CRD001-001, P/O TB-16	Couples V-2B to DL-1
C-17	4	CAPACITOR, Fixed, Paper Dielectric, 200 VDCW, 47K uuf ±20%, plastic case, hermetically sealed, 1¼ in long x ⁷⁄₁₆ in dia, 2 axial leads, SPR type 106P, WPD Part No. CPB006-014	Couples DL-1 to grid of V-3
C-18		Same as C-13	Couples plate of V-3 to grid of V-4
C-19		Same as C-15, P/O TB-2	Signal by-pass for grid of V-5
C-20		Same as C-11, P/O TB-2	Couples plate of V-4 to deflection plate of CR tube V-6

Note: 4. Replace with the substitute part having the stock number listed in Table 8-3

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C-21		Same as C-11, P/O TB-2	Couples plate of V-5 to deflection plate of CR tube V-6
C-22		CAPACITOR, Fixed, Plastic Dielectric, 2000 VDCW, 50,000 uuf ±10%, tubular glass case with metal end seals, not insulated, 1¾ in long x ¾ in dia, 2 No. 8-32 axial studs, COPC type ASG-503-2M, WPD Part No. CEC001-005, P/O TB-10	Couples plate of V-24 to grid of CR tube V-6
C-23		CAPACITOR, Fixed, Plastic Dielectric, 2000 VDCW, 5,000 uuf ±10%, tubular glass case with metal end seals, not insulated, 1 3/16 in long x 19/32 in dia, 2 axial leads, COPC type ASG-502-2M, WPD Part No. CEC001-003, P/O TB-10	Couples plate of V-22 to cathode of CR tube V-6
C-24		Same as C-15, P/O TB-10	Part of decoupling network in grid circuit of CR tube V-6
C-25		CAPACITOR, Fixed, Plastic Dielectric, 2000 VDCW, 250,000 uuf ±10%, tubular glass case with metal end seals, not insulated, 2¾ in long x 29/32 in dia, 2 No. 8-32 axial studs, COPC type ASG-254-2M, WPD Part No. CEC001-001, P/O TB-10	Part of negative high voltage supply filter network
C-26A, B, C		CAPACITOR, Fixed, Electrolytic, 3 sect, sect (a) 450 VDCW, 10 uf −10% to +50% tol, sect (b) 450 VDCW, 15 uf −10% to +50%, tol, sect (c) 450 VDCW, 15 uf −10% to +50% tol, −40 deg C to +85 deg C working temp range, tubular metal case, not insulated, 3 in long x 1 in dia, MAL type WP, WPD Part No. CDE002-003	Filter for 250 VDC supply and second anode voltage of CR tube V-6
C-27A, B, C		CAPACITOR, Fixed, Electrolytic, 3 sect, sect (a) 250 VDCW, 10 uf −10% to +50% tol, sect (b) 450 VDCW, 20 uf −10% to +50% tol, sect (c) 450 VDCW, 20 uf −10% to +50% tol, −40 deg C to +85 deg C working temp range, tubular metal case, not insulated, 3 in long x 1 in dia, MAL type WP, WPD Part No. CDE002-004	Filter for 250 VDC supply and decoupling for V-7
C-28		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 270 uuf ±10%, JAN CM20B271K, spec MIL-C-5, P/O TB-13	Test voltage compensating capacitor
C-29		Same as C-17, P/O TB-13	Couples part of output of V-7A to J-3
C-30		CAPACITOR, Fixed, Mica Dielectric, 300 VDCW, 18 uuf ±10%, plastic case, ½ in lg x 9/32 in wide x 3/16 in thk, 2 axial leads, JAN CM15B180K, spec MIL-C-5, P/O TB-13	Part of shaping network in grid of V-7A
C-31		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 250 uuf ±5%, plastic case, ½ in lg x 9/32 in wide x 3/16 in thk, 2 axial leads, EMM type CM15, WPD Part No. CZB004-017, P/O TB-13	Part of timing network in grid of V-7A
C-32		Same as C-31, P/O TB-13	Part of timing network in grid of V-7B
C-33		Same as C-30, P/O TB-13	Part of shaping network in grid of V-7B
C-34		Same as C-17, P/O TB-13	Couples output of V-7B to R-78
C-35		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 1300 uuf ±10%, plastic case, 25/32 in long x 7/16 in wide x 7/32 in deep, 2 axial leads, EMM type CM20, WPD Part No. CZB005-003, P/O TB-13	Cal voltage compensating capacitor
C-36	4	CAPACITOR, Fixed, Mica Dielectric, 1 Kuuf ±10%, 300 VDCW, plastic case, 47/64 in long, 7/16 in wide, 3/16 in deep, 2 axial leads, CM20B102K per MIL-C-5	Cal voltage compensating capacitor
C-37	4	CAPACITOR, Fixed, Electrolytic, 80 uf, −10% to +50%, 450 VDCW, metal case, tubular, 2½ in lg, 1⅜ in dia, MAL type WP, WPD Part No. CDE002-013	Part of plate decoupling filter for V1 and V2B
C-38		Same as C-36	Part of decoupling network for screen grids of V4 and V5
C-39		CAPACITOR, Fixed, Electrolytic, 25 VDCW, 200 uf, −15% to +100% tol, −40 deg C to +85 deg C working temp range, tubular metal case, not insulated, 1 9/16 in long x ⅞ in dia, MAL type TAL, WPD Part No. CRD001-007, P/O TB-14	Filter for blower motor DC supply

Note: 4. Replace with the substitute part having the stock number listed in Table 8-3

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C-40A, B		CAPACITOR, Fixed, Electrolytic, 2 sect, each sect 350 VDCW, 20 uf, −10% to +50% tol, −40 deg C to +85 deg C working temp range, tubular metal case, not insulated, 2 11/16 in long x 1 in dia, 3 wire leads, MAL type TAD, WPD Part No. CRD001-010, P/O TB-14	Filter for 500 VDC supply
C-41		CAPACITOR, Fixed, Electrolytic, 1 sect, 250 VDCW, 20 uf, −10% to +50% tol, −40 deg C to +85 deg C working temp range, tubular metal case, not insulated, 1 9/16 in long x 3/4 in dia, 2 axial leads, clamp mtd, MAL type TA, WPD Part No. CRD001-006, P/O TB-14	Filter for negative 200 VDC supply
C-42		CAPACITOR, Fixed, Electrolytic, 1 sect, 250 VDCW, 30 uf, −10% to +50% tol, −40 deg C to +85 deg C working temp range, tubular metal case, not insulated, 1 9/16 in long x 7/8 in dia, MAL type TAL, WPD Part No. CRD001-008, P/O TB-14	Filter for negative 200 VDC supply
C-43		CAPACITOR, Fixed, Electrolytic, 1 sect, 350 VDCW, 20 uf, −10% to +50% tol, −40 deg C to +85 deg C working temp range, tubular metal case, not insulated, 1 9/16 in long x 7/8 in dia, MAL type TAL, WPD Part No. CRD001-009, P/O TB-14	Filter for negative 200 VDC supply
C-44		CAPACITOR, Fixed, Plastic Dielectric, 3000 VDCW, 100,000 uuf ±10%, tubular glass case with metal end seals, not insulated, 2 1/4 in long x 1 1/8 in dia, 2 No. 8-32 axial studs, COPC type ASG-104-3M, WPD Part No. CEC001-006, P/O TB-15	Filter for positive high voltage supply
C-45		Same as C-25, P/O TB-15	Filter for negative high voltage supply
C-46		CAPACITOR, Fixed, Plastic Dielectric, 2000 VDCW, 100,000 uuf ±10%, tubular glass case with metal end seals, not insulated, 2 1/4 in long x 3/4 in dia, 2 No. 8-32 axial studs, COPC type ASG-104-2M, WPD Part No. CEC001-002, P/O TB-15	Filter for negative high voltage supply
C-47		Same as C-1, P/O TB-5	Series capacitive element of sync input attenuator
C-48		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 330 uuf ±10%, JAN CM20B331K, spec MIL-C-5	Shunt capacitive element of sync input attenuator
C-49		CAPACITOR, Fixed, Paper Dielectric, 400 VDCW, 10,000 uuf ±20%, plastic case, hermetically sealed, 1 1/4 in long x 3/8 in dia, 2 axial leads, SPR type 106P, WPD Part No. CPB006-002, P/O TB-5	SYNC input coupling to V-14A
C-50A, B, C		CAPACITOR, Fixed, Electrolytic, 3 sect, sect (a) 350 VDCW, 10 uf, −10% to +50% tol, sect (b) 350 VDCW, 10 uf, −10% to +50% tol, sect (c) 350 VDCW, 10 uf, −10% to +50% tol, −40 deg C to +85 deg C working temp range, tubular metal case, not insulated, 2 1/2 in long x 1 in dia, MAL type WP, WPD Part No. CDE002-010	Decoupling for V-14, V-26A, V-27, V-16B and V-17A from power supply
C-51		Same as C-49, P/O TB-5	Coupling from SYNC control to grid of V-14B
C-52		Same as C-49, P/O TB-6	Couples plate of V-14B to grid of V-16B
C-53		CAPACITOR, Fixed, Mica Dielectric, 510 uuf, ±5%, 300 VDCW, plastic case, 47/64 in long x 7/16 in wide x 3/16 in deep, 2 axial wire leads, JAN CM20B511J, spec MIL-C-5	Delays cathode bias rise at V-16 after triggering of sweep
C-54		Same as C-1, P/O Z-3	Adjustable timing capacity on .5-5 μs sweep range
C-55		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 33 uuf ±10%, JAN CM20B330K, spec MIL-C-5	Part of timing capacity for .5-5 μs sweep range
C-56		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 620 uuf ±5%, JAN CM25B621J, spec MIL-C-5	Timing capacity for 5-50 μs sweep range
C-57		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 6200 uuf ±5%, JAN CM35B622J, spec MIL-C-5	Timing capacity for 50-500 μs sweep range

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C-58		CAPACITOR, Fixed, Paper Dielectric, 200 VDCW, 62,000 uuf ±5%, plastic case, hermetically sealed, 1½ in long x ½ in dia, 2 axial leads, SPR type 106P, WPD Part No. CPB006-012, P/O Z-3	Timing capacity for 500-5K μs sweep range
C-59		CAPACITOR, Fixed, Paper Dielectric, bathtub style, 200 VDCW, 600,000 uuf ±5%, −55 to +85 deg C working temp range, rectangular metal case, 1 13/16 in long x 1 in wide x 7/8 in high, two 3/16 in dia mtg holes on 1⅛ in mtg/C, two top mtd terminals, TBD type XR-187, WPD Part No. COB006-002	Timing capacity for 5K-50K μs sweep range
C-60A, B, C		CAPACITOR, Fixed, Electrolytic, 3 sect, sect (a) 350 VDCW, 10 uf, −10% to +50% tol, sect (b) 350 VDCW, 10 uf −10% to +50% tol, sect (c) 450 VDCW, 30 uf, −10% to +50% tol, −20 deg C to +85 deg C working temp range, tubular metal case, not insulated, 3 in long x 1 in dia, MAL type WP, WPD Part No. CDE002-011	Decoupling for V-17B, V-26B, V-28B
C-61		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 22 uuf ±10%, JAN CM20B220K, spec MIL-C-5, P/O TB-7	Compensation in feedback coupling V-17B to V-16A
C-62		CAPACITOR, Fixed, Mica Dielectric, 300 VDCW, 100 uuf ±10%, JAN CM15B101K, spec MIL-C-5	Decoupling in grid circuit of V-16A
C-63		CAPACITOR, Fixed, Mica Dielectric, 300 VDCW, 27 uuf ±10%, JAN CM15B270K, spec MIL-C-5, P/O TB-7	Provides AC coupling to grid of V-18B
C-64		CAPACITOR, Variable, Ceramic Dielectric, rotary type, 3 uuf min, 12 uuf max, 350 VDCW, 17/32 in dia, 19/32 in deep including terminals, ERC type 557-14, WPD Part No. CYA003-003	Timing capacitor for 0.2 μs markers
C-65		Same as C-1, P/O Z-2	Adjustable element of 1 μs marker timing capacity
C-66		CAPACITOR, Fixed, Mica Dielectric, 300 VDCW, 39 uuf ±10%, JAN CM15C390K, spec MIL-C-5, P/O Z-2	Fixed element of 1 μs marker timing capacity
C-67		Same as C-1, P/O TB-10	High frequency portion of intensity gate attenuator to grid of V6
C-68		CAPACITOR, Fixed, Mica Dielectric, 300 VDCW, 150 uuf ±10%, JAN CM15C151K, spec MIL-C-5, P/O Z-2	Timing capacitor for 10 μs markers
C-69		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 1800 uuf ±10%, JAN CM30C182K, spec MIL-C-5, P/O Z-2	Timing capacitor for 100 μs markers
C-70		CAPACITOR, Fixed, Mica Dielectric, 300 VDCW, 8200 uuf ±10%, JAN CM35C822K, spec MIL-C-5, P/O Z-2	Timing capacitor for 500 μs markers
C-71A, B, C		CAPACITOR, Fixed, Electrolytic, 3 sect, sect (a) 250 VDCW, 20 uf, −10% to +50% tol, sect (b) 250 VDCW, 10 uf, −10% to +50% tol, sect (c) 350 VDCW, 20 uf, −10% to +50% tol, −40 deg C to +85 deg C working temp range, tubular metal case, not insulated, 2½ in long x 1 in dia, MAL type WP, WPD Part No. CDE-002-009	Decoupling for V-21, V-22, V-23
C-72		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 130 uuf ±5%, JAN CM20B131J, spec MIL-C-5, P/O Z-2	Part of differentiator for 0.2 μs markers
C-73		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 470 uuf ±10%, JAN CM20B471K, spec MIL-C-5, P/O Z-2	Part of differentiator for 1 μs marker
C-74		Same as C-36, P/O Z-2	Part of differentiator for 10 μs markers
C-75		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 2200 uuf ±10%, JAN CM30B222K, spec MIL-C-5, P/O Z-2	Part of differentiator for 100 μs markers
C-76		Same as C-70, P/O Z-2	Part of differentiator for 500 μs markers
C-77		Same as C-49, P/O Z-2	AC coupling from J-6 to V-22 grid

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C-78		CAPACITOR, Fixed, Electrolytic, 1 sect, 25 VDCW, 10 uf, −10% to +100% tol, −40 deg C to +85 deg C working temp range, tubular metal case with vinyl insulating sleeve, 1 1/16 in long x 1/2 in dia, 2 axial leads, MAL type TA, WPD Part No. CRD001-003, P/O TB-12	By-pass capacitor for V-22 bias network
C-79		Same as C-49, P/O Z-4	Couples V-23 to J-7
C-80		Same as C-11, P/O TB-12	Decoupling for V-23
C-81		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 5100 uuf ±5%, JAN CM35B512J, spec JAN-C-5, P/O Z-4	Part of trigger rate timing network in grid of V-23
C-82		CAPACITOR, Fixed, Electrolytic, 1 sect, 300 VDCW, 20 uf, −10% to +20% tol, −20 deg C to +85 deg C working temp range, tubular metal case, not insulated, 1 7/16 in long x 3/4 in dia, 2 axial leads, MAL type TA, WPD Part No. CRD001-017, P/O TB-7	Decoupling and compensation for V-24
C-83		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 4.7 uuf ±10%, plastic case 25/32 in long x 7/16 in wide x 7/32 in deep, 2 axial leads, EMM type CM15, WPD Part No. CZB004-018	Provides AC coupling from V-16A to V-26B
C-84		Same as C-78, P/O TB-7	By-pass for V-25B amplitude limiting voltage divider
C-85		CAPACITOR, Fixed, Electrolytic, 1 sect, 350 VDCW, 10 uf, −20% to +100% tol, −40 deg C to +85 deg C working temp range, tubular metal case with vinyl insulating sleeve, 1 5/16 in long x 3/4 in dia, 2 axial leads, MAL type TA, WPD Part No. CRD001-005, P/O TB-7	Linearization feedback from V-26A to V-26B
C-86		CAPACITOR, Variable, Ceramic Dielectric, rotary type, 500 VDCW, 3 uuf min, 13 uuf max, JAN CV11B130, spec JAN-C-81, P/O TB-6	Part of amplitude capacity for .5-5 μs sweep range
C-87		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 18 uuf ±10%, JAN CM20B180K, spec MIL-C-5, P/O Z-3	Part of amplitude capacity for .5-5 μs sweep range
C-88		Same as C-53, P/O Z-3	Amplitude capacitor for 5-50 μs sweep range
C-89		Same as C-81, P/O Z-3	Amplitude capacitor for 50-500 μs sweep range
C-90		CAPACITOR, Fixed, Paper Dielectric, 200 VDCW, 51,000 uuf ±5%, plastic case, hermetically sealed, 1 1/4 in long x 7/16 in dia, 2 axial leads, SPR type 106P, WPD Part No. CPB006-011, P/O Z-3	Amplitude capacitor for 500-5K μs sweep range
C-91		CAPACITOR, Fixed, Paper Dielectric, bathtub style, 200 VDCW, 500,000 uuf ±5%, −55 to +85 deg C working temp range, rectangular metal case, 1 13/16 in long x 1 in wide x 3/4 in high, two 3/16 in dia mtg holes on 1 1/8 in mtg/C, two top mounted terminals, TBD type XR-186, WPD Part No. COB006-001	Amplitude capacitor for 5K-50K μs sweep range
C-92	4	CAPACITOR, Fixed, Mica Dielectric, 300 VDCW, 510 uuf ±10%, plastic case, 33/64 in long x 19/64 in wide x 3/16 in deep, 2 axial wire leads JAN CM15B511K, spec MIL-C-5	High frequency coupling from expanded sweep amplifier
C-93		Same as C-15, P/O TB-7	Coupling from V-26A to V-27B or V-28B
C-94		Same as C-36	Signal by-pass for V-27A grid
C-95		Same as C-11, P/O TB-5	AC coupling from J-10 to V-28B grid
C-96		Same as C-1, P/O TB-5	Series compensating capacitor for attenuator in grid circuit of V-28B
C-97		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 56 uuf ±10%, JAN CM20B560K, spec MIL-C-5	Compensating capacitor at grid of V-28B
C-98		Same as C-53	Cathode peaking for V-28B

Note: 4. Replace with the substitute part having the stock number listed in Table 8-3

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C-99		CAPACITOR, Fixed, Paper Dielectric, 600 VDCW, 47K uuf ±20%, plastic case, 1½ in long x ½ in dia, 2 axial wire leads, SPR type 106P, WPD Part No. CPB006-013	Couples V-28B to V-29A
C-100		Same as C-15, P/O TB-7	Signal by-pass for V-29B grid
C-101		CAPACITOR, Fixed, Ceramic Dielectric, disc type, 500 VDCW, 4700 uuf, −20% to +100% tol, JAN CK62Y472Z, spec MIL-C-11015A	Couples V-2B to V-2A
C-102		Same as C-53	Cathode peaking for V-2A
C-103A, B		CAPACITOR, Fixed, Electrolytic, 2 sect, sect (a) 350 VDCW, 20 uf −10 +50% tol, sect (b) 350 VDCW, 3 uf −10 +50% tol, metal case, hermetically sealed, three solder lug type term, 1 13/16 in lg x 1 in dia, spec JAN -C-62 char C, MAL type TADL, WPD Part No. CRD001-018	A. Decoupling for plate of V3 B. Decoupling for screen of V1
C-104		CAPACITOR, Fixed, Ceramic, Dielectric, 3 uuf, ±1 uuf, JAN CC20-GJ030F	Input capacity compensation for 1 range of V MULTIPLIER switch
CR-1		RECTIFIER, Metallic, selenium, single phase full wave CKT, 14.5 V single phase input, 15.5 VDC @ 0.260 amp output full wave rectification, ¾ x ¾ x 1¼ in long, one 11/64 in dia mtg hole, salt spray resistant coating, FDR type 403D8379, WPD Part No. ERS007-001	Blower motor power supply rectifier
CR-2		RECTIFIER, Metallic, selenium, single phase half wave CKT, 272 V single phase input, 280 VDC @ 0.025 amp output half wave rectification, 1 x 1 x 2¼ in long, two No. 8-32 mtg studs, salt spray resistant coating, FDR type 302D8410S, WPD Part No. ERS008-001	500 V supply rectifier
CR-3		Same as CR-2	Negative 200 V supply rectifier
DL-1		NETWORK, Pulse Delay, 0.55 microseconds delay time, 2 terminals, solder lug type, located at one end, 5.967 in lg, including terminals, x 27/32 in wide x 2 25/32 in high including mtg boss, 2 No. 6-32 mtg bosses on bottom spaced 5.234 in c/c one No. 6-32 mtg boss centered on top, WPD Part No. DEC035-A01	Delays V-input signal
DS-1		LAMP, Incandescent, 6.3 V, 0.15 amp, min bayonet base, bulk T-3¼, clear white light emitted, filament MBCA group 7, C-6 GLEC type 47, WPD Part No. VLA002-001	Heater on indicator
DS-2		Same as DS-1	Power on indicator
DS-3		Same as DS-1	Illumination of scale at CRT face
DS-4		Same as DS-1	Illumination of scale at CRT face
DS-5		KNOB, Set screw type, fluted round shape, positive gripping surface, phenolic body, 1½ in max OD, 13/16 in thk O/A, w/skirt, integrally molded, accommodates plain round shaft, ¼ in dia, 9/16 in deep shaft hole, two socket type set screws, painted body, black, w/insert, brass, white filled indicator line DHM type 4104, WPD Part No. NKB013-001	Indicate position of S-1, S-10, S-11, S-13, S-14
DS-6		KNOB, Set screw type, round with bar face, pos gripping surface, phenolic body, 11/16 in max OD, ½ in thk, straight shank, accommodates plain rd, shaft, ¼ in dia, 15/16 in depth of hole, one socket head set screw, painted body, black, w/o markings, CPT type 24073, WPD Part No. NKB010-002	Indicate position of R-25, R-51A, B, R-58, R-62, R-98, R-106, R-120A, B, R-126, R-187, R-193, R-196, S-2, S-15
DS-7	1	DIAL, Scale, clockwise range of inscription .1 to 1.0, linear, 90 scale divisions, 2¾ in dia x ⅝ in thk including knob, mounts on ¼ in dia rd shaft with two Allen head set screws, scale black, etched aluminum with natural marking, attached knob, black, molded, phenolic, WPD Part No. DMB156-A01	Indicates peak to peak calibration voltage

Note: 1. Low Failure Items—If required requisition from ESO, referencing NAVSHIPS 900, 180A

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
E-1		POST, Binding, cap data: brass, nickel plated, w/screw action, knurled, not removable; base data: brass, nickel plated, 1 1/16 in overall height of post above mtg surface, 3/8 in dia O/A, 6-32 mtg stud, 9/16 in long, EBY type SD-41, WPD Part No. ETM003-001	GND post at V INPUT
E-2	2	TERMINAL, Screw Type, brass, tinned, 8-32 screw connection, solder lug rear terminal, JON type 110-112, WPD Part No. HTE-030-001, P/O TB-4	V DIRECT input connector
E-3		Same as E-2, P/O TB-4	GND connection at V-DIRECT input
E-4		Same as E-1	GND post at SYNC input
E-5		Same as E-1	GND post at BEAM MOD INPUT
E-6		BRUSH, Electrical Contact, rectangular shape, carbon, .124 x .124 x 5/16 in long, concave contact face, set of 2 each, WPD Part No. ENA002-001, P/O B-1C	Commutator brush for B-1 Motor
E-6A		BRUSH, Electrical Contact, same as E-6 except unit package of two WPD Part No. ENA002-002, P/O B-1C	Commutator brushes for B-1 Motor
E-7		SHIELD, Electron Tube, accommodates RMA tube envelope style J24G, straight cylinder shape, open top, one opening provided specifically for electrode leads, not vented, nickel alloy (Mu-Metal) 4 5/16 in dia x 8 in high, mounts on panel (CRT shield) 3 holes for 6-32 screw on 3 27/32 in dia circle, 120 deg apart, WPD Part No. DMC043-A01	Outer electromagnetic shield
E-8		SHIELD, Electron Tube, straight cylinder shape with three fingers spot welded at one end, open top, not vented, steel, 5 3/16 in long x 2 11/32 in approx dia, mounts directly on tube, WPD Part No. DMB111-A01	Inner electromagnetic shield for V-6
E-9		CONTACT, Electrical, brass, gold plate over silver plate, 1.031 in long x .140 in max dia, .067 in dia solder pot, EBY Part No. 977511F, WPD Part No. HTE045-001	Removable electrical connections on interconnection terminal boards
E-10		Not Used	
E-11		CLIP, Electrical, brass, tinned, 1 13/64 in long x 27/64 in high x 47/64 in wide black rubber insulation one solder lug type terminal, for small button third anode cathode ray tube connector, equipped with 10 in lead wire, WPD Part No. DEA032-A01	Apply voltage to third anode of CRT
E-12		BASE, Shield, electron tube, brass nickel plate, two 0.250 in dia mtg holes, mounts with tube socket mtg hardware, holding attachment for min 7 prong tube shield, EBY Part No. 9061, WPD Part No. MPA063-002	Shields for base of V-1, V-3, V-15, V-20, V-22, V-25
E-13		BASE, Shield, electron tube, brass, nickel plate, two 0.128 in dia mtg holes, mounts with tube socket mtg hardware, holding attachment for min 9 prong tube shield, EBY Part No. 9716-11, WPD Part No. MPA064-001	Shields for base of V-2, V-7, V-12, V-13, V-14, V-21, V-23
E-14		SHIELD, Electron Tube, brass, nickel plate, cylindrical shape, 1 15/16 in long x 0.950 in ID, bayonet mtg, JAN TS103U02, spec JAN-S-28	Shields for V-2, V-7, V-12, V-13, V-14, V-21, V-23
E-15		SHIELD, Electron Tube, brass, nickel plate, cylindrical shape, 1 3/8 in long x 13/16 in ID, bayonet mtg, JAN TS102U01, spec JAN-S-28	Shields for V-15, V-25
E-16		SHIELD, Electron Tube, brass, nickel plate, cylindrical shape, 1 3/4 in long x 13/16 in ID, bayonet mtg, JAN TS102U02, spec JAN-S-28	Shields for V-1, V-3, V-20, V-22
E-17		RETAINER, Electron Tube, c/o two main pieces, phosphor bronze, cad plate, 3/4 in long x 7/16 in wide x 2 1/32 in high (WPD Dwg MBB-088-002), retains 7 pin min medium electron tube, mtd with tube socket, includes locking spring, WPD Part No. DMB172-A02	Retainers for V-4, V-5, V-24

Note: 2. Shop manufacture

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
E-18		RETAINER, Electron Tube, c/o two main pieces, phosphor bronze, cad plate, 3/4 in long x 7/16 in wide x 2 7/16 in high, (WPD Dwg MBB-088-003) retains 7 pin min tall electron tube, mtd with tube socket, includes locking spring, WPD Part No. DMB172-A03	Retainer for V-19
E-19		RETAINER, Electron Tube, c/o two main pieces, phosphor bronze, cad plate, 5/8 in long x 9/16 in wide x 2 1/32 in high (WPD Dwg MBB-087-002), retains 9 pin min medium electron tube, mtd with tube socket, includes locking spring, WPD Part No. DMB171-A02	Retainers for V-16, V-17, V-18, V-26, V-27, V-28, V-29
E-20		RETAINER, Electron Tube, c/o two main pieces, phosphor bronze, cad plate, 5/8 in long x 9/16 in wide x 2 7/16 in high (WPD Dwg MBB-087-003), retains 9 pin min tall electron tube, mtd with tube socket, includes locking spring WPD Part No. DMB171-A03	Retainers for V-8, V-9, V-10, V-11
F-1		FUSE, Cartridge, 4 amp, 250 V, normal instantaneous, ferrule type, 1 1/4 in long x 1/4 in dia, glass body, one time, JAN FCZG4R00A, spec MIL-F-15160C	Primary line fuse
F-2		Same as F-1	Primary line fuse
F-3		Same as F-1	Primary line fuse spare
F-4		Same as F-1	Primary line fuse spare
FL-1		FILTER, Radio Interference, assembly c/o two 30 microhenry coils wound on powered iron core forms, four 5000 uuf 1000 VDC ceramic capacitors and J-4 mounted in cylindrical metal case with flange on one end, overall dimensions 2 1/16 in long x 1 5/8 in wide x 2 1/2 in deep, including terminals, two 5/32 in dia mtg holes spaced 1.750 in c/c WPD Part No. DEB066-A01	Prevents radio frequencies from feeding into power line
HR-1		HEATER, Space, electric, resistor, fixed, WW, 1000 ohms ±10%, 20W, 250 deg C operating temp, JAN RW20G102, spec JAN-R-26	Space heater
J-1		CONNECTOR, Receptacle, one female contact, styramic insert, straight type, 3/4 x 3/4 x 1 1/16 in long, bayonet type, four 0.136 in dia mtg holes spaced 0.531 in c/c UG-185/U, spec MIL-C-3608	V INPUT connector
J-2		CONNECTOR, Receptacle, AN3102A-14S-7S spec MIL-C-5015 WPD, Part No. ECC011-001	PROBE POWER supply connector
J-3		Same as J-1	TEST VOLTS OUTPUT connector
J-4		CONNECTOR, Receptacle, Electrical, 3 male contacts, 2 curved lipped, one round, 10 amp 250 V, 15 amp 125 V, plastic insert, straight shape, 1 1/8 in x 1 3/4 in x 2 5/16 in, locking type, twist type, two 0.156 in dia mtg holes spaced 1 3/4 in, HAW type 7486, P/O FL-1	POWER INPUT connector
J-5		Same as J-1	SYNC INPUT connector
J-6		Same as J-1	BEAM MOD INPUT connector
J-7		Same as J-1	Negative TRIGGER OUTPUT
J-8		Same as J-1	Positive TRIGGER OUTPUT connector
J-9		Same as J-1	SWEEP OUTPUT connector
J-10		Same as J-1	H INPUT connector
L-1		COIL, Radio Frequency, 1 winding, universal wound, 13 microhenry center inductance at 1 MC, powered iron core, adjustable core tuning, screwdriver adjustment, not cased, 27/32 in long x 5/16 in dia, 2 solder lug terminals, mounts in single 0.180 in dia hole, 10 MC core, Q of 40 at 5 MC, WPD Part No. LLV005-002	Shunt peaking for V-1
L-2		COIL, Radio Frequency, 1 winding, universal wound, 25 microhenry center inductance at 1 MC, powdered iron core, adjustable core tuning, screwdriver adjustment, not cased, 27/32 in long x 1/4 in dia, 2 solder lug terminals, mounts in single 0.180 in dia hole, 10 MC core, Q of 45 min at 250 KC, WPD Part No. LLV005-009	Shunt peaking for V-3

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
L-3		COIL, Radio Frequency, 1 winding, universal wound, 36 microhenry center inductance at 1 MC, powdered iron core, adjustable core tuning, screwdriver adjustment, not cased, 27/32 in long x 5/16 in dia, 2 solder lug terminals, mounts in single 0.180 in dia hole, 10 MC core, Q of 40 at 2.5 MC, WPD Part No. LLV005-004	Shunt peaking for V-4
L-4		Same as L-3	Shunt peaking for V-5
L-5		COIL, Radio Frequency, 1 winding, universal wound, 15 microhenry center inductance at 1 MC, powdered iron core, adjustable core tuning, screwdriver adjustment, no case, 27/32 in long x 5/16 in dia, 2 solder lug terminals, mounts in single 0.180 in. dia. hole, 10 MC core, Q of 40 at 5 MC, WPD Part No. LLV005-003	Series peaking for V-4
L-6		Same as L-2	Series peaking for V-5
L-7		REACTOR, Fixed Inductance type, 1 sect, 5 HY, 265 MA DC, 65 ohms DC resistance, 800 V RMS test voltage, open frame, 3½ in long x 2¾ in wide x 3⅛ in high, 4 integral mtg feet, 2 13/16 in x 2½ in mtg centers, 2 solder lug terminals on side, assembly covered moisture resistant finish, WPD Part No. LCB009-A01	Reactance section of filter for plate voltage supply
L-8		COIL, Radio Frequency, 1 winding, universal wound, 100 microhenry ±10% at 500 KC, powdered iron core, not adjustable, not cased, 1 in long x ¼ in dia, 2 axial leads, Q of 75 at 500 KC, WPD Part No. LLU024-001	Shunt peaking for V-14B
L-9		COIL, Radio Frequency, 1 winding, universal wound, 155 microhenry ±10% at 500 KC, powdered iron core, not adjustable, not cased, 1 in long x ¼ in dia, 2 axial leads, Q of 75 at 500 KC, WPD Part No. LLU024-002, P/O TB-7	Shunt peaking for V-17B
L-10		COIL, Radio Frequency, 1 winding, universal wound, 28 to 58 microhenry at 1 MC, powdered iron core, adjustable core, not cased, 27/32 in long x 5/16 in dia, 2 solder lug terminals, mounts in single 0.180 in dia hole, 10 MC core, Q of 40 at 2.5 MC, WPD Part No. LLV005-008, P/O Z-2	Shunt peaking for V-21A
L-11		COIL, Radio Frequency, 1 winding, universal wound, 57 microhenry ±10% at 500 KC, powdered iron core, not adjustable, not cased, 1 in long x ¼ in dia, 2 axial leads, Q of 75 at 500 KC, WPD Part No. LLU024-003	Peaking for .2 and 1 μs markers
L-12		Same as L-10, P/O TB-12	Shunt peaking for V-22
L-13		COIL, Radio Frequency, 1 winding, universal wound, 11 millihenry ±10% at 100 KC, powdered iron core, not adjustable, not cased, 1 in long x ¼ in dia, 2 axial leads, Q of 70 at 100 KC, WPD Part No. LLU022-001, P/O TB-7	Shunt peaking for V-29A
L-14		Same as L-13, P/O TB-7	Shunt peaking for V-29B
L-15		COIL, Radio Frequency, 1 winding, universal wind, 8.4 microhenries, ±10%, powdered iron core, not adjustable, not cased, ¾ in long x ¼ in dia, axial wire lead terminals, Q of 65-10% + 50% @ 7.9 MC, WPD Part No. LLU024-004	Part of delay line output terminating impedance
L-16		Same as L-15, P/O TB-16	Part of DL-1 input matching impedance
L-17		COIL, Radio Frequency, 1 winding universal wind, 5 millihenries, ±5%, paper base molded form, not adjustable, not cased, 1 in lg x 9/16 in dia, nylon phenol collar, solder lug term spaced 90°, Q of 45 min at 250 KC, WPD Part No. LLU025-001	Shunt peaking coil for V-27A
MP-1		SHIELD, Light, aluminum, black finish exterior, 4¼ in OD, 15/16 in long, four 0.125 in mtg holes spaced 90 deg apart on 1 15/32 in radius mtd with N-1 and N-2, WPD Part No. MTA010-001	Encloses DS-3 and DS-4 and forms light shield around face of CRT

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
MP-2	1	POINTER, Dial, aluminum, black paladin fin, stationary, 5/16 in dia x 9/16 in long, single hole mtg with 6-32 stud, engraved line natural aluminum, used with Dial N-3, WPD Part No. MNA028-001	Reference index for CAL voltage
MP-3	1	NUT, Plain, round, cold rolled steel, cad plated, 3/8-32 inside thrd, spanner drive, face slot type, 2 drive points, .125 in wide, .046 in deep, 0.437 in OD, .109 in long, WPD Part No. HNZ014-002	Mounting for R-79, R-106, R-120, R-126, R-187, R-193, S-2, S-15
MP-4	1	PLATE, Mounting, capacitor, steel, cad plated, holds 1 3/8 in dia twist prong type capacitors, two 0.130 in dia mtg holes spaced 1 13/16 in, 2 3/16 in long x 1 17/32 in wide, PBN type MP1375, WPD Part No. MAC003-001	Mounting for C-14
MP-5	1	PLATE, Mounting, capacitor, steel, cad plated, holds 1 in dia twist prong capacitors, two 0.138 in dia mtg holes spaced 1 1/2 in, 1 7/8 in long x 1 11/32 in wide, PBN type MP1000, WPD Part No. MAC002-002	Mounting for C-26, C-27, C-50, C-60, C-71
MP-6		COUPLING, Shaft, flexible, flexible disc type, steel, cad plated, accommodates 1/4 in dia round shaft at each end, 1 1/8 in OD, 2 1/32 in long, set screw mtd, two 8-32 x 3/16 on one end two 8-32 x 1/4 in on other end, linen base phenolic body flexible element OAK type 6403-64, WPD Part No. DMA041-001	Coupling for marker generator and trigger generator control shafts
MP-7		BUSHING, Panel, steel, cad plated, hex shape at one end, 1/2 in A/F, 3/8-32 threaded body, 3/8 in long, shaft bearing surface 0.050 to 0.065 in long, remainder of internal length 0.277 in, 7/16 in long overall, WPD Part No. MUS014-001	Panel bearing for marker generator and trigger generator shafts
MP-8	2	CLAMP, Electrical, Steel, cad plated, 1/2 in wide x 5/8 in high x 1 3/32 in long O/A, 0.140 in dia mtg hole, holds 9/16 in dia tub part, WPD Part No. MNA041-001	Mounts C-11
MP-9		CLAMP, Electrical, Plastic, ethyl cellulose, 1/2 in wide x 1 1/16 in high x 1 7/16 in long O/A, 13/64 in dia holes at mtg ends of loop, holds 15/16 in dia tub part, WECK type 15/16W, WPD Part No. IPM008-019	Mounts C-103A/B
MP-10		CLAMP, Electrical, Plastic, ethyl cellulose, 1/2 in wide x 9/16 in high x 1 1/16 in long O/A, 13/64 in dia mtg holes at mtg ends of loop, holds 7/16 in dia tub part, CPW type 742-7, WPD Part No. IPM008-006	Mounts C-17
MP-11		CLAMP, Electrical, Plastic, ethyl cellulose, 1/2 in wide x 5/8 in high x 1 1/32 in long O/A, 13/64 in dia mtg holes at mtg ends of loop, holds 1/2 in dia tub part, WECK type 1/2W, WPD Part No. IPM008-007	Mounts C-99, L-13, L-14
MP-12		CLAMP, Tube Shield, cathode ray tube, steel, zinc Iridite finish, approx. 2 3/16 in dia, x 3/4 in deep, 2 mtg ears 90° apart, each mtg ear 1 mtg hole tapped 6-32 thd, WPD Part No. DMB121-A02	Supports outer cathode ray tube
MP-13		CLAMP, Electrical, nylon, black 1/2 in wide x 1 in high x 1 1/2 in long O/A, 13/64 dia mtg holes at mtg ends of loop, holds 7/8 in tub part, WPD Part No. IPM009-007	Mounts C-16
MP-14		BRACKET, Supporting, resistor, steel, cad plated, contains 2 glass insulated term, each glass insulated term contains 2 wire loop solder type terminations, 2 slotted mtg holes on 1 13/16 in centers, WPD Part No. DMA068-A01	Supports R213 and R214
MP-15	1	STRIP, Capacitor mounting, steel, chromate treated, cad plated 1.000 in lg x 0.250 wide x 0.094 thk, 1 tapped hole for 4-40 thd on 1/2 in center, WPD Part No. MWA073-002	Mounts C-13 and C-18

Note: 1. Low Failure Items—If required requisition from ESO, referencing NAVSHIPS 900, 180A
2. Shop manufacture

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
N-1	1	SCALE, Cathode Ray Tube, 25 horizontal graduations, 15 vertical graduations, each graduation 0.1 in markings engraved in clear plexiglass for edge illuminations, 3¼ in dia, 0.1 in thk, four 0.125 in dia mtg holes spaced at 90 deg on $1^{15}/_{32}$ in radius, assembled with escutcheon and filter, WPD Part No. IPM006-001	Scale at CRT face
N-2		FILTER, Light, Cathode Ray Tube, green, cellulose acetate, 3¼ in dia x .020 in thk, four 0.156 in dia mtg holes spaced at 90 deg on $1^{15}/_{32}$ in radius, assembled with escutcheon and scale, WPD Part No. IPC013-001	Overlay for scale, reduces incident light interference
R-1		RESISTOR, Fixed, Film, 300,000 ohms ±1%, 1W, JAN RN25X-3003F, spec MIL-R-10509A, P/O Z-1	Resistance element of series arm of V-MULTIPLIER on 300 range
R-2		RESISTOR, Fixed, Film, 297,000 ohms ±1%, 1W, JAN RN25X-2973F, spec MIL-R-10509A, P/O Z-1	Resistance element of series arm of V-MULTIPLIER on 100 range
R-3		RESISTOR, Fixed, Film, 290,000 ohms ±1%, 1W, JAN RN25X-2903F, spec MIL-R-10509A, P/O Z-1	Resistance element of series arm of V-MULTIPLIER on 30 range
R-4		RESISTOR, Fixed, Film, 270,000 ohms ±1%, 1W, JAN RN25X-2703F, spec MIL-R 10509A, P/O Z-1	Resistance element of series arm of V-MULTIPLIER on 10 range
R-5		RESISTOR, Fixed, Film, 200,000 ohms ±1%, 1W, JAN RN25X-2003F, spec MIL-R-10509A, P/O Z-1	Resistance element of series arm of V-MULTIPLIER on 3 range
R-6	4	RESISTOR, Fixed, Film, 1,000 ohms ±1%, ½W, JAN RN20X-1001F, spec MIL-R-10509A, P/O Z-1	Resistance element of shunt arm of V-MULTIPLIER on 300 range
R-7	4	RESISTOR, Fixed, Film, 3,000 ohms ±1%, ½W, JAN RN20X-3001F, spec MIL-R-10509A, P/O Z-1	Resistance element of shunt arm of V-MULTIPLIER on 100 range
R-8	4	RESISTOR, Fixed, Film, 10,000 ohms ±1%, ½W, JAN RN20X-1002F, spec MIL-R-10509A, P/O Z-1	Resistance element of shunt arm of V-MULTIPLIER on 30 range
R-9	4	RESISTOR, Fixed, Film, 30,000 ohms ±1%, ½W, JAN RN20X-3002F, spec MIL-R-10509A, P/O Z-1	Resistance element of shunt arm of V-MULTIPLIER on 10 range
R-10	4	RESISTOR, Fixed, Film, 105,000 ohms ±1%, ½W, JAN RN20X-1053F, spec MIL-R-10509A, P/O Z-1	Resistance element of shunt arm of V-MULTIPLIER on 3 range
R-11		RESISTOR, Fixed, Film, 348,000 ohms ±1%, 1W, JAN RN25X-3483F, spec MIL-R-10509A, P/O Z-1	Determines input resistance for 1 multiplier step of V-MULTIPLIER
R-12		RESISTOR, Fixed, Comp, 2.2 meg ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF225K, spec JAN-R-11	Grid resistor for V-1
R-13		RESISTOR, Fixed, Comp, 47 ohms ±10%, ½W, R/T char F, 0.375 long x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF470K, spec JAN-R-11	Suppresses parasitic oscillations in V-1
R-14		RESISTOR, Fixed, Comp, 1200 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF122K, spec JAN-R-11	Plate load resistor for V-1
R-15		RESISTOR, Fixed Composition, 51K ohms ±5%, 1 watt, .562 in long x .225 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC32GF513J, spec JAN-R-11	Suppresses parasitic oscillations in V-1

Note: 1. Low Failure Items—If required requisition from ESO, referencing NAVSHIPS 900, 180A
4. Replace with the substitute part having the stock number listed in Table 8-3

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R-16		RESISTOR, Fixed, Comp, 91 ohms ±5%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF910J, spec JAN-R-11	Provides cathode bias for V-1
R-17		RESISTOR, Fixed Composition, 33K ohms, ±10%, ½ watt, .375 in long x .140 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF333K, spec JAN-R-11, P/O TB-2	Part of decoupling network for grid of V-5
R-18		RESISTOR, Fixed Composition, 1.5 Megohms ±10%, ½ watt, .375 in long x .140 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF155K, spec JAN-R-11, P/O TB-2	Grid resistor for V-2B
R-19		RESISTOR, Fixed, Comp, 4700 ohms ±10%, ½W, 0.375 lg x 0.140 in dia, R/T char F, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF472K, spec JAN-R-11, P/O TB-2	Plate load resistor for V-2A
R-20		RESISTOR, Fixed Composition, 510 ohms, ±5%, ½ watt, .375 in long x .140 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF511J, spec JAN-R-11, P/O TB-2	Cathode bias and part of cathode load resistance of V-2B
R-21		RESISTOR, Fixed Comp, 10,000 ohms ±10%, 1W, 0.562 lg x 0.225 in dia, R/T char F, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF103K, spec JAN-R-11, P/O TB-2	Part of cathode load resistance for V-2B
R-22		RESISTOR, Fixed Carbon, 12K ohms, ±10%, 2 watt, .688 in long x .312 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC42GF123K, spec JAN-R-11, P/O TB-2	Part of decoupling filter for plate of V-2A and PROBE POWER
R-23		RESISTOR, Wirewound (power type), 9000 ohms, ±5%, 12 watt, 2 in long x 19/32 in dia, char. G 2 tab terminals tubular, JAN RW32G902, spec MIL-R-26B, P/O TB-2	Part of plate decoupling filter for V1 and V2B
R-24		RESISTOR, Fixed Composition, 390 ohms, ±10%, ½ watt, .375 in long x .140 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF391K, spec JAN-R-11, P/O TB-16	Part of delay line input matching impedance
R-25		RESISTOR, Variable, WW, 1 sect, 1000 ohms ±10%, 2W, A taper, metal case enclosed, 1 17/64 in dia x ⅝ in deep, single shaft, metal, rd, ¼ in dia, 9/16 in lg mtd by bushing, ⅜-32 x ¼ in lg, CPH type 252, WPD Part No. RWB008-002	V-GAIN control
R-26		RESISTOR, Fixed, Comp, 180 ohms, ±5%, ½W, 0.375 lg x 0.140 in dia, R/T char F, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF181J, spec JAN-R-11	Limits range of V-GAIN control
R-27		RESISTOR, Fixed, Comp, 10 meg ±10%, ½W, 0.375 lg x 0.140 in dia, R/T char F, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF106K, spec JAN-R-11	Grid resistor of V-3
R-28		RESISTOR, Fixed Composition, 12K ohms, ±5%, ½ watt, .375 in long x .140 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF123J, spec JAN-R-11	Damping resistor for coil L-5
R-29		RESISTOR, Fixed, Comp, 1800 ohms ±5%, ½W, 0.375 in lg x 0.140 in dia, char F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF182J, spec JAN-R-11	Plate load resistor for V-3
R-30		Same as R-13	Parasitic suppressor for V-3
R-31		RESISTOR, Fixed, Comp, 2200 ohms ±10%, 2W, R/T char. F, 0.688 lg x 0.312 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC42GF222K, spec JAN-R-11, P/O TB-2	Part of decoupling for V-3 from 250 volt supply
R-32		Same as R-31, P/O TB-2	Part of decoupling for V-3 from 250 volt supply
R-33		Same as R-13	Parasitic suppressor for V-4
R-34		RESISTOR, Fixed, Composition, 1 megohm, ±10%, ½ watt, .375 in long x .140 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF105K, spec JAN-R-11	Grid resistor for V-4

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R-35		RESISTOR, Fixed, WW, 800 ohms ±10%, 25W, 225 deg C operating temp, 25 deg C ambient temp, 2⅞ lg x 23/32 in dia glazed ceramic tube coating, 2 lug terminals, mtg hardware required, SPR type 25NIT, WPD Part No. RMB004-001	Load resistor for signal coupled from V-4 to V-5
R-36		RESISTOR, Fixed Composition, 47 ohms, ±5%, 1 watt, .375 in long x .140 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF470J, spec JAN-R-11	Common bias resistor for V-4 and V-5
R-37		Same as R-34	Grid resistor for V-5
R-38		Same as R-13	Parasitic suppressor for V-5
R-39		RESISTOR, Fixed Composition, 750 ohms, ±5%, 2 watt, .688 in long x .312 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC42GF751J, spec JAN-R-11, P/O TB-3	Part of plate load resistance for V-4
R-40		Same as R-39, P/O TB-3	Part of plate load resistance for V-4
R-41		RESISTOR, Fixed Comp, 5600 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF562K, spec JAN-R-11	Reduce Q of coil L-3 in plate circuit of V-4
R-42		Same as R-13	Parasitic suppressor for V-4
R-43		Same as R-13	Parasitic suppressor for V-5
R-44		Same as R-31, P/O TB-2	Screen dropping resistor for V-4 and V-5
R-45		Same as R-41	Reduce Q of coil L-4 in plate circuit of V-5
R-46		RESISTOR, Fixed Composition, 910 ohms, ±5%, 2 watt, .688 in long x .312 in dia, char. F, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC42GF911J, spec JAN-R-11, P/O TB-3	Part of plate load resistance for V-5
R-47		Same as for R-46, P/O TB-3	Part of plate load resistance for V-5
R-48		Same as R-12, P/O TB-2	Plate impedance for vertical deflection plate of V-6
R-49		Same as R-12, P/O TB-2	Plate impedance for vertical deflection plate of V-6
R-50		RESISTOR, Variable, Comp, 1 sect, 250,000 ohms ±20%, ¼W, A taper, metal case enclosed, 15/16 in dia x 29/64 in deep, single shaft, metal, rd, slotted 3/64 in wide x 1/16 in deep, ¼ in dia, ⅜ in lg, mtd by bushing, ⅜-32 x ¼ in lg, high torque, CPH type 45HT, WPD Part No. RVD002-013	ASTIGMATISM control
R-51A, B		RESISTOR, Variable, Comp, 2 sect, each section 500,000 ohms ±10%, ¼W, A taper, metal case enclosed, 15/16 in dia, ⅞ in deep, single shaft, metal, rd, ¼ in dia, 9/16 in lg, mtd by bushing, ⅜-32 x ¼ in long CPH type 2-45, WPD Part No. RVD002-014	V POS control
R-52		RESISTOR, Fixed, Comp, 220,000 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF224K, spec JAN-R-11	Part of ASTIGMATISM V-POS network
R-53		RESISTOR, Fixed, Comp, 12 meg ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF126K, spec JAN-R-11, P/O TB-10	Part of bleeder for positive high voltage supply for V-6
R-54		Same as R-53, P/O TB-10	Part of bleeder for positive high voltage suplpy for V-6
R-55		Same as R-53, P/O TB-10	Part of bleeder for positive high voltage supply for V-6
R-56		RESISTOR, Fixed, Comp, 820,000 ohms ±10%, 1W, R/T Char F, 0.562 in lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF824K, spec JAN-R-11, P/O TB-10	Part of bleeder for positive high voltage supply for V-6

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R-57		Same as R-56, P/O TB-10	Part of bleeder for positive high voltage supply for V-6
R-58		RESISTOR, Variable, Comp, 500,000 ohms ±20%, ¼W, A taper, metal case enclosed, 15/16 in dia x 1 9/16 in deep, single shaft, metal, rd, ¼ in dia, 9/16 in lg, mtd by bushing, 3/8-32 x ¼ in lg, insulated from mtg surface by 1 in bakelite mtg standoff and concentric shaft with nylon insulating section, CRL type M, WPD Part No. RVB-006-001	FOCUS control for V-6
R-59		RESISTOR, Fixed, Comp, 560,000 ohms ±10%, 1W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF564K, spec JAN-R-11, P/O TB-10	Part of bleeder for negative high voltage supply for V-6
R-60		RESISTOR, Fixed, Comp, 100,000 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF104K, spec JAN-R-11, P/O TB-10	Cathode load for CRT, V-6
R-61		RESISTOR, Fixed, Comp, 2700 ohms ±10%, 1W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF272K, spec JAN-R-11, P/O TB-10	Range limiting for BEAM control of V-6
R-62		RESISTOR, Variable, Comp, 200,000 ohms ±20%, ¼W, A taper, metal case enclosed, 15/16 in dia x 9/16 in deep, single shaft, metal rd, ¼ in dia, 9/16 in lg, mtd by bushing, 3/8-32 x ¼ in lg, insulated from mtg surface by 1 in bakelite mtg standoff and concentric shaft with nylon insulating section, CRL type M, WPD Part No. RVB006-002	BEAM control for V-6
R-63		RESISTOR, Fixed Composition, 470K ohms, ±10%, 1 watt, char. F, .562 in long x .225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC32GF474K, spec JAN-R-11, P/O TB-10	Filter for negative high voltage supply
R-64		RESISTOR, Fixed Composition, 150K ohms ±10%, ½ watt, char. F, .375 in long x .142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF154K, spec JAN-R-11, P/O TB-10	Part of decoupling in grid circuit of CRT V-6
R-65		Same as R-52, P/O TB-12	Part of second anode supply network for V-6
R-66		RESISTOR, Variable, Comp, 1 sect, 300,000 ohms ±20%, ¼W, A taper, metal case enclosed, 15/16 in dia, 2 9/64 in deep, single shaft, metal, rd, slotted 3/64 wide x 1/16 in deep, ¼ in dia, 3/8 in lg, mtd by bushing, 3/8-32 x ¼ in long, high torque, CPH type HT45, WPD Part No. RVD002-015	Second anode adjustment for V-6
R-67		RESISTOR, Fixed, Comp, 330,000 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF334K, spec JAN-R-11	Limits range of second anode adjustment for V-6
R-68		RESISTOR, Fixed, Comp, 47,000 ohms ±5%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF473J, spec JAN-R-11, P/O TB-13	Part of voltage divider to give proper test voltage output
R-69		RESISTOR, Fixed, Comp, 82,000 ohms ±5%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF823J, spec JAN-R-11, P/O TB-13	Part of voltage divider for test voltage output
R-70		RESISTOR, Fixed, Comp, 1.2 meg ±5%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF125J, spec JAN-R-11, P/O TB-13	Part of timing resistor for grid of V-7A
R-71		RESISTOR, Fixed, Comp, 15,000 ohms ±5%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF153J, spec JAN-R-11, P/O TB-13	Part of shaping network in grid of V-7A
R-72		RESISTOR, Fixed, Comp, 10,000 ohms ±5%, 1W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF103J, spec JAN-R-11, P/O TB-13	Plate load resistor of V-7A
R-73		Same as R-72, P/O TB-13	Plate load resistor of V-7B

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R-74		Same as R-71, P/O TB-13	Part of shaping network in grid of V-7B
R-75		Same as R-70, P/O TB-13	Part of timing resistor for grid of V-7B
R-76		RESISTOR, Fixed, Comp, 3300 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF332K, spec JAN-R-11, P/O TB-13	Part of decoupling filter for V-7
R-77		RESISTOR, Fixed, Comp, 120,000 ohms ±5%, ½W, R/T char F. 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF124J, spec JAN-R-11, P/O TB-13	Part of V-7B output attenuator
R-78		RESISTOR, Variable, Comp, 1 sect, 10,000 ohms ±20%, ¼W, A taper, metal case enclosed, 15/16 in dia, 29/64 in deep, single shaft, metal, rd, slotted 3/16 in wide x 1/16 in deep, ¼ in dia, ⅜ in lg mtd by bushing ⅜-32 x ¼ in lg, high torque, CPH type HT45, WPD Part No. RVD002-016	CAL voltage 1 volt adjustment
R-79		RESISTOR, Variable, WW, 1 sect, 5,000 ohms ±10%, 2W, A taper, metal case enclosed, 1 17/64 in dia, ⅝ in deep single shaft, metal, rd, ¼ in dia, ⅞ in lg, mtd by bushing, ⅜-32 x ⅜ in lg, JAN RA20A1RD502AK, spec JAN-R-10, CPH type 252, WPD RWB008-004	Varies the amplitude of the CAL voltage signal from 0.1 to 1 volt applied to V-1
R-80		RESISTOR, Variable, Comp, 1 sect, 1,000 ohms ±20%, ¼W, A taper, 15/16 in dia, 29/64 in deep, single shaft, metal, rd, slotted 3/16 in wide x 1/16 in deep, ¼ in dia, ⅜ in lg, mtd by bushing, ⅜-32 x ¼ in lg, high torque, CPH type HT45, WPD Part No. RVD002-017	0.1 volt adjustment for R-79
R-81		RESISTOR, Fixed, Comp, 5100 ohms ±5%, 2W, R/T char F, 0.688 in lg x 0.312 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC42GF512J, spec JAN-R-11, P/O TB-14	Filter for 500VDC supply
R-82		Same as R-81, P/O TB-14	Filter for 500VDC supply
R-83		RESISTOR, Fixed, Comp, 39 ohms ±10%, ½W, R/T char F. 0.375 in lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF390K, spec JAN-R-11, P/O TB-13	Current equalizing resistor in plate circuit of V-8
R-84		Same as R-83, P/O TB-13	Current equalizing resistor in plate circuit of V-9
R-85		Same as R-83, P/O TB-13	Current equalizing resistor in plate circuit of V-10
R-86		Same as R-83, P/O TB-13	Current equalizing resistor in plate circuit of V-11
R-87		Same as R-83, P/O TB-13	Current equalizing resistor in plate circuit of V-8
R-88		Same as R-83, P/O TB-13	Current equalizing resistor in plate circuit of V-9
R-89		Same as R-83, P/O TB-13	Current equalizing resistor in plate circuit of V-10
R-90		Same as R-83, P/O TB-13	Current equalizing resistor in plate circuit of V-11
R-91		RESISTOR, Fixed, Comp, 1800 ohms ±5%, 2W, R/T char F, 0.750 lg x 0.280 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC42GF812J, spec JAN-R-11, P/O TB-14	Filter for negative 200V supply
R-92		Same as R-91, P/O TB-14	Filter for negative 200V supply
R-93		Same as R-63, P/O TB-15	Filter and current limiting resistor in positive high voltage supply
R-94		RESISTOR, Fixed Composition, 510K ohms ±5%, ½ watt, char. F, .375 in long x .142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF514J, spec JAN-R-11, P/O TB-10	Grid resistor for CRT V-6

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R-95		RESISTOR, Fixed, WW, 1.5 ohms ±10%, ½W, 110 deg C operating temp, JAN RU3AIR5K, spec JAN-R-184, P/O TB-15	Filament dropping resistor for V-12
R-96		Same as R-95, P/O TB-15	Filament dropping resistor for V-13
R-97	4	RESISTOR, Fixed, Comp, 33 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF330K, spec JAN-R-11, P/O TB-14	Voltage dropping resistor for DS-2
R-98		RESISTOR, Variable, WW, 1 sect, 35 ohms ±10%, 2W, A taper, metal case enclosed, 1 17/64 in dia, 57/64 in deep, single shaft, metal, rd, ¼ in dia, 9/16 in lg, mtd by bushing, 3/8-32 x ¼ in lg, with switch, SPST, 3 amp, 125 VAC, normally open at CCW position of shaft, operates at start of rotation, (switch S-9) CPH type GC-252, WPD Part No. RWB008-003	SCALE ILLUMINATION control
R-99		RESISTOR, Fixed, Comp, 300,000 ohms ±5%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF304J, spec JAN-R-11, P/O TB-5	Resistance element of series arm of SYNC INPUT attenuator
R-100		RESISTOR, Fixed, Comp, 10,000 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF103K, spec JAN-R-11	Resistance element of shunt arm of SYNC INPUT attenuator
R-101		RESISTOR, Fixed, Comp, 2700 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF272K, spec JAN-R-11	Decoupling and filter for V-14
R-102		RESISTOR, Fixed, Comp, 56 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF560K, spec JAN-R-11	Parasitic suppressor for V-14A
R-103		Same as R-34	Grid return for V-14A
R-104		Same as R-24	Part of cathode load for V-14A
R-105		RESISTOR, Fixed, Comp, 470 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF471K, spec JAN-R-11	Part of cathode load for V-14A
R-106		RESISTOR, Variable, Comp, 1 sect, 2,000 ohms ±10%, ¼W, A taper, metal case enclosed, 15/16 in dia, 29/64 in deep single shaft, metal, rd, ¼ in dia, 11/16 in lg, mtd by bushing, 3/8-32 x 3/8 in lg, CPH type 45, WPD Part No. RVD002-018	SYNC polarity and gain control in cathode circuit of V-14A
R-107		Same as R-34	Grid return for V-14B
R-108		RESISTOR, Fixed, Comp, 240 ohms ±5%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF241J, spec JAN-R-11	Part of cathode load for V-14
R-109		Same as R-105	Part of cathode load for V-14
R-110		RESISTOR, Fixed, Comp, 2200 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF222K, spec JAN-R-11	Plate load resistor for V-14B
R-111		Same as R-34	Grid return for V-16B
R-112		RESISTOR, Fixed, Comp, 1500 ohms ±10%, 1W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF152K, spec JAN-R-11, P/O TB-6	Decoupling and filter for V-16B and V-17A
R-113		RESISTOR, Fixed, Comp, 22,000 ohms ±5%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF223J, spec JAN-R-11, P/O TB-6	Plate load resistor for V-16B
R-114		RESISTOR, Fixed Composition, 1K ohm, ±10%, ½W, char. F, .375 in long x .142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF102K, spec JAN-R-11	Cathode bias resistor for V-16
R-115		Same as R-61, P/O TB-6	Decoupling and filter for V-16A and V-17B

Note: 4. Replace with the substitute part having the stock number listed in Table 8-3

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R-116		RESISTOR, Fixed, Comp, 12,000 ohms ±5%, 1W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF123K, spec JAN-R-11, P/O TB-7	Plate load resistor for V-16A
R-117		Same as R-102, P/O TB-7	Parasitic suppressor for V-16A
R-118		RESISTOR, Fixed, Comp, 18,000 ohms ±5%, 2W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC42GF183J, spec JAN-R-11, P/O TB-7	Cathode load resistor for V-17A
R-119		Same as R-100	Limits range of FINE SWEEP control
R-120A, B		RESISTOR, Variable, Comp, 2 sect, sect (a) 1 meg, sect (b) 125,000 ohms, each section ±10%, ¼W, A taper, metal case enclosed, 15/16 in dia, 7/8 in deep, single shaft, metal, rd, ¼ in dia, 11/16 in lg, mtd by bushing, 3/8-32 x 3/8 in lg, CPH type 2-45, WPD Part No. RVD002-019	FINE SWEEP control
R-121		Same as R-102, P/O TB-7	Parasitic suppressor for V-17B
R-122		RESISTOR, Fixed, Comp, 5600 ohms ±10%, 2W, R/T char F, 0.688 lg x 0.312 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC42GF562K, spec JAN-R-11, P/O TB-7	Plate load resistor for V-17B
R-123		RESISTOR, Fixed, Comp, 180,000 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF184K, spec JAN-R-11, P/O TB-7	Part of sweep feedback coupling for V-16A
R-124		Same as R-52, P/O TB-7	Part of sweep feedback for V-16A
R-125		RESISTOR, Fixed Composition, 47K ohms, ±10%, ½ watt, char. F, .375 in long x .142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF473K, spec JAN-R-11	Limits range of SWEEP STABILITY control
R-126		RESISTOR, Variable, Comp, 1 sect, 100,000 ohms ±10%, ¼W, A taper, metal case enclosed, 59/64 in dia, 23/32 in deep, single shaft, metal, rd, ¼ in dia, 11/16 in lg, mtd by bushing, 3/8-32 x 3/8 in lg, with switch, SPDT, 3 amp, 125 VAC, operates at start of rotation, 4 solder lug terminals (switch S-12) CPH type VF45, WPD Part No. RVD002-020	SWEEP STABILITY control
R-127		RESISTOR, Variable, Comp, one sect, 100,000 ohms ±10%, ¼W, A taper, metal case enclosed, 15/16 in dia, 29/64 in deep, single shaft, metal, rd, slotted 3/64 in wide x 1/16 in deep, ¼ in dia, ½ in long, mtd by bushing, 3/8-32 x 3/8 in long, high torque, CPH type HT45, WPD Part No. RVD002-027	Fixed bias adjust for trigger operation
R-128		RESISTOR, Fixed, Comp, 910,000 ohms ±5%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF914J, spec JAN-R-11, P/O TB-7	Provides DC coupling to grid of V-18B
R-129		Same as R-34, P/O TB-12	Grid return for V-18B
R-130		RESISTOR, Variable, Comp, 1 sect, 1 meg, ±20%, ¼W, A taper, metal case enclosed, 15/16 in dia, 29/64 in deep, single shaft, metal, rd, slotted, 3/64 in wide x 1/16 in deep, ¼ in dia, 3/8 in lg, mtd by bushing 3/8-32 x ¼ in long, high torque, CPH type HT45, WPD Part No. RVD002-021	Keying gate adjustment
R-131		Same as R-71, P/O TB-12	Plate load resistor for V-18B
R-132		RESISTOR, Fixed, Comp, 9100 ohms ±5% ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF912J, spec JAN-R-11	Cathode load resistor for V-18B
R-133		RESISTOR, Fixed, WW, 2000 ohms ±5%, 9W, 215 deg C operating temp, JAN RW56J202, spec JAN-R-26, P/O TB-12	Dropping resistor for 150 volts regulated supply
R-134		RESISTOR, Fixed, Comp, 120,000 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF124K, spec JAN-R-11, P/O TB-12	Limits range of DC level adjustment

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R-135		RESISTOR, Variable, Comp, 1 sect, 25,000 ohms ±20%, ¼W, A taper, metal case enclosed 15/16 in dia, 29/64 in deep, single shaft, metal, rd, slotted, 3/64 in wide x 1/16 in deep, ¼ in dia, ⅜ in long, mtd by bushing, ⅜-32 x ¼ in lg, high torque, CPH type HT45, WPD Part No. RVD002-028	Sets DC level for V-21
R-136		Same as R-76	Cathode load resistor for V-20
R-137		RESISTOR, Fixed, Comp, 1,000 ohms ±10%, 1W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF102K, spec JAN-R-11, P/O TB-12	Decouples V-21 from regulated 150 volt supply
R-138		Same as R-100, P/O Z-2	Reduce Q of L-10 in plate circuit of V-21A
R-139		RESISTOR, Fixed, Film, 1,000 ohms ±1%, 1W, JAN RN25X-1001F, spec MIL-R-10509A, P/O Z-2	Plate load resistor for V-21A
R-140	4	RESISTOR, Fixed, Film, 560 ohms ±1%, ½W, JAN RN20X5600F, spec MIL-R-10509A, P/O Z-2	Timing resistor for 0.2 microsecond markers in grid circuit of V-21B
R-141		RESISTOR, Variable, Comp, 1 sect, 100,000 ohms ±20%, ¼W, A taper, metal case enclosed, 15/16 in dia, 29/64 in deep, single shaft, metal, rd, slotted, 3/64 in wide x 1/16 in deep, ¼ in dia, ⅜ in lg, mtd by bushing, ⅜-32 x ¼ in lg, high torque, CPH type HT45, WPD Part No. RVD002-022	Timing resistor adjustment for 500 microsecond markers
R-142		Same as R-141	Timing resistor adjustment for 100 microsecond markers
R-143	4	RESISTOR, Fixed, Comp, 39,000 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF393K, spec JAN-R-11, P/O Z-2	Part of timing resistance for 10 microsecond markers
R-144	4	RESISTOR, Fixed, Film, 5600 ohms ±1%, ½W, JAN RN20X5601F, spec MIL-R-10509A, P/O Z-2	Timing resistance for 1 microsecond markers
R-145		Same as R-100, P/O Z-2	Grid ground return resistor for V-21B
R-146	4	RESISTOR, Fixed, Comp, 390 ohms ±1%, ½W, JAN RN20X3900F, spec MIL-R-10509A, P/O Z-2	Part of cathode load resistance for V-21
R-147	4	RESISTOR, Fixed, Comp, 560 ohms ±1%, 1W, JAN RN25X5600F, spec MIL-R-10509A, P/O Z-2	Part of cathode load resistance for V-21
R-148		RESISTOR, Fixed, Comp, 680 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF681K, spec JAN-R-11	Marker differentiating resistor
R-149		RESISTOR, Fixed, Comp, 22,000 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF223K, spec JAN-R-11, P/O TB-12	Reduce Q of L-11
R-150		RESISTOR, Fixed, Comp, 56,000 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF563K, spec JAN-R-11	Grid return resistor for V-22
R-151		RESISTOR, Fixed, Comp, 27,000 ohms ±10%, 2W, R/T char F, 0.688 lg x 0.312 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC42GF273K, spec JAN-R-11, P/O TB-12	Decoupling and filter for V-22
R-152		Same as R-14, P/O TB-12	Plate load resistor for V-22
R-153		RESISTOR, Fixed, Comp, 15,000 ohms ±5%, 1W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF153J, spec JAN-R-11, P/O TB-12	Dropping resistor for suppressor grid of V-22
R-154		Same as R-100, P/O TB-12	Reduce Q of coil L-12 in plate circuit of V-22

Note: 4. Replace with the substitute part having the stock number listed in Table 8-3

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R-155		Same as R-13, P/O TB-12	Parasitic suppressor for V-22
R-156		Same as R-24, P/O TB-12	Cathode bias resistor for V-22
R-157		RESISTOR, Fixed, Comp, 120 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF121K, spec JAN-R-11, P/O TB-12	Part of filter and decoupling for V-23
R-158		Same as R-157, P/O Z-4	Plate load resistor for V-23
R-159		RESISTOR, Fixed, Comp., 100 ohms, ±5%, ½ watt, char F, .375 in long x .142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF101J, spec JAN-R-11, P/O Z-4	Part of cathode load resistor of V-23
R-160		RESISTOR, Fixed Composition, 18 ohms, ±5%, ½ watt, char. F, .375 in long x .142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF180J, spec JAN-R-11, P/O Z-4	Part of cathode load resistor for V-23
R-161	4	RESISTOR, Fixed, Film, 2.05 meg ±1%, ½W, JAN RN20X2054F, spec MIL-R-10509A, P/O Z-4	Timing resistor for 50 PPS
R-162	4	RESISTOR, Fixed, Film, 333,000 ohms ±1%, ½W, JAN RN20X-3333F, spec MIL-R-10509A, P/O Z-4	Timing resistor for 300 PPS
R-163	4	RESISTOR, Fixed, Film, 118,000 ohms ±1%, ½W, JAN RN20X-1183F, spec MIL-R-10509A, P/O Z-4	Timing resistor for 800 PPS
R-164	4	RESISTOR, Fixed, Film, 40,000 ohms ±1%, ½W, JAN RN20X-4002F, spec MIL-R-10509A, P/O Z-4	Timing resistor for 2000 PPS
R-165		Same as R-8, P/O Z-4	Timing resistor for 5000 PPS
R-166		Same as R-8, P/O Z-4	Part of voltage divider for bias on V-23
R-167		Same as R-64, P/O Z-4	Part of voltage divider for bias on V-23
R-168		RESISTOR, Variable, Comp, 1 sect, 200,000 ohms ±20%, ¼W, A taper, metal case enclosed, 15/16 in dia, 2 9/64 in deep, single shaft, metal, rd, slotted 3/64 in wide x 1/16 in deep, ¼ in dia, ⅜ in lg, mtd by bushing, ⅜-32 x ¼ in lg, high torque, CPH type HT45, WPD Part No. RVD002-023	Trigger rate adjust
R-169		RESISTOR, Fixed, Comp, 22,000 ohms ±10%, 2W, R/T char F, 0.688 lg x 0.312 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC42GF223K, spec JAN-R-11, P/O TB-7	Decoupling and filter for V-24
R-170		Same as R-41, P/O TB-7	Plate load resistor for V-24
R-171		RESISTOR, Fixed, Comp, 750,000 ohms ±5%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF754J, spec JAN-R-11	Provides DC coupling from V-16A to V-26B
R-172		RESISTOR, Fixed Comp, 1.1 megohms, ±5%, ½ watt, char. F, .375 in long x .142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF115J, spec JAN-R-11, P/O TB-6	Grid return resistor for V-26B
R-173		RESISTOR, Fixed, Comp, 39,000 ohms ±10%, 2W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF393K, spec JAN-R-11, P/O TB-7	Part of amplitude limiting voltage divider for V-26B
R-174		Same as R-14	Part of amplitude limiting voltage divider for V-26B
R-175		Same as R-143	Limits minimum range of fine frequency control
R-176		RESISTOR, Fixed, Comp, 27,000 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF273K, spec JAN-R-11, P/O TB-7	Part of fine frequency range limiting and linearization feedback for V-26B
R-177		Same as R-100, P/O TB-7	Filter and decoupling for V-26B

Note: 4. Replace with the substitute part having the stock number listed in Table 8-3

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R-178		RESISTOR, Fixed, Comp, 2200 ohms ±10%, 1W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF222K, spec JAN-R-11, P/O TB-6	Filter and decoupling for V-26A and V-27
R-179		RESISTOR, Fixed, Comp, 5600 ohms ±5%, 1W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF562J, spec JAN-R-11, P/O TB-7	Part of cathode load for V-26A
R-180		RESISTOR, Fixed, Comp, 6200 ohms ±5%, 2W, R/T char F, 0.688 lg x 0.312 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC42GF622J, spec JAN-R-11, P/O TB-7	Part of cathode load for V-26A
R-181		Same as R-12	Grid resistor for V-27B
R-182		RESISTOR, Fixed, Comp, 820 ohms, ±10%, ½ watt, char. F, .375 in long x .142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF821K, spec JAN-R-11	Damping resistor for coil L-17
R-183		RESISTOR, Fixed, Comp, 13,000 ohms ±5%, ½W, R/T char F, 0.375 lg x 0.142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF133J, spec JAN-R-11	Plate load resistor for V-27A
R-184		RESISTOR, Fixed Comp, 47,000 ohms ±10%, 2W, R/T char F, 0.688 lg x 0.312 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC42GF473K, spec JAN-R-11, P/O TB-6	Common cathode load resistor for coupling signal from V-27B to V-27A
R-185		Same as R-34, P/O TB-7	Grid limiting resistor for V-27A
R-186		Same as R-50	Delayed sweep range setting adjust for V-27A
R-187		RESISTOR, Variable, Comp, 1 sect, 50,000 ohms ±10%, ¼W, A taper, 15/16 in dia, 2 9/64 in deep, metal case enclosed, single shaft, metal, rd, ¼ in dia, 11/16 in lg, mtd by bushing, 3/8-32 x 3/8 in lg, CPH type 45, WPD Part No. RVD002-024	SWEEP DELAY control
R-188		Not used	
R-189		RESISTOR, Fixed, Comp, 4.7 meg ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF475K, spec JAN-R-11, P/O TB-5	Part of attenuator to grid of V-28B
R-190		Same as R-18	Grid resistor for V-28B
R-191		RESISTOR, Fixed, Comp, 15,000 ohms, ±10%, 2W, char. F, 0.688 in lg x 0.312 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC42GF153K, spec JAN-R-11, P/O TB-7	Bleeder for plate supply of V-28
R-192		RESISTOR, Fixed, Comp, 6800 ohms ±10%, 1W, R/T char F, 0.562 lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF682K, spec JAN-R-11, P/O TB-7	Filter and decoupling for V-28B
R-193		RESISTOR, Variable, Comp, 1 sect, 25,000 ohms ±10%, ½W, A taper, metal case enclosed, 1⅛ in dia, ½ in deep, single shaft, metal, rd, ¼ in dia, 11/16 in lg, mtd by bushing, 3/8-32 x 3/8 in lg, CPH type 45, WPD Part No. RVD002-025	H GAIN control
R-194		RESISTOR, Fixed Comp, 1800 ohms, ±10%, ½ watt, char. F, .375 in long x .142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF182K, spec JAN-R-11	Cathode bias resistor for V-28B
R-195		Same as R-27	Grid resistor for V-29A
R-196		RESISTOR, Variable, Comp, 1 sect, 25,000 ohms ±10%, ¼W, A taper, metal case enclosed, 15/16 in dia, 2 9/64 in deep, single shaft, metal, rd, ¼ in dia, 9/16 in lg, mtd by bushing, 3/8-32 x ¼ in lg, CPH type 45, WPD Part No. RVD002-026	H POS control
R-197		Same as R-60, P/O TB-7	Limits range of H POS control
R-198		RESISTOR, Fixed, Comp, 5.6 meg ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF565K, spec JAN-R-11, P/O TB-7	Grid return for V-29B

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R-199		Same as R-191, P/O TB-7	Part of plate load for V-29A
R-200		Same as R-191, P/O TB-7	Part of plate load for V-29A
R-201		RESISTOR, Fixed, Comp, 7500 ohms ±5%, 2W, R/T char F, 0.688 lg x 0.312 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC42GF752J, spec JAN-R-11, P/O TB-7	Part of cathode load resistance coupling signal from V-29A to V-29B
R-202		Same as R-201, P/O TB-7	Part of cathode load resistance coupling signal from V-29A to V-29B
R-203		Same as R-191, P/O TB-7	Part of plate load for V-29B
R-204		Same as R-169, P/O TB-7	Part of plate load for V-29B
R-205		Same as R-12	Grid return for V-2A
R-206		RESISTOR, Fixed, Comp, 270 ohms ±10%, ½W, R/T char F, 0.375 lg x 0.140 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC20GF271K, spec JAN-R-11	Cathode bias resistor for V-2A
R-207		Same as R-60, P/O TB-13	Part of timing resistor for grid of V-7A
R-208		Same as R-60, P/O TB-13	Part of timing resistor for grid of V-7B
R-209		Same as R-135	Timing resistor adjustment for 10 microsecond markers
R-210		Same as R-108	Grid current limiting resistor for V-23
R-211		RESISTOR, Fixed, Comp, 5.6 ohms ±10%, 1W, R/T char F, 0.562 in lg x 0.225 in dia, insulated, resistant to humidity and/or salt spray, 2 axial leads, JAN RC32GF5R6K, spec JAN-R-11, P/O TB-14	Current limiting resistor for B-1
R-212		Same as R-157, P/O TB-12	Part of filter and decoupling for V-23
R-213		Same as R-13	Current limiting and protective resistor for CR-2
R-214		Same as R-13	Current limiting and protective resistor for CR-3
R-215		Same as R-23	Part of plate decoupling filter for V-1 and V-2B
R-216		RESISTOR, Fixed Comp, 150K ohms, ±10%, 2 W, char. F, 0.688 in lg x 0.312 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC42GF154K, spec JAN-R-11	Protective bleeder resistor for V-1 and V-2B and C-14A
R-217		RESISTOR, Fixed Comp, 680K ohms, ±10%, ½ W, char. F, 0.375 in lg x 0.142 in dia, insulated, resistant to humidity and/or salt spray, 2 axial wire leads, JAN RC20GF684K, spec JAN-R-11, P/O TB-10	Low frequency portion of intensity gate attenuator to grid of V-6
R-218		Same as R-41	Part of plate load resistor for V-27A
R-219		Same as R-176	Range limiter for H POS control during expanded sweep operation
S-1		SWITCH, Rotary, sectional type, 2 sect, 6 positions max possible, non-pile-up type, 2 moving contacts, 10 dummy terminals, 2 poles, 6 throws, not electrically rated, shorting type contacts, $2^{19}/_{32}$ in lg x $1^{13}/_{32}$ in wide x $1^{17}/_{32}$ in high, rd shaft, ⅞ in lg, ¼ in dia, mtd by bushing, ⅜-32 x ⅜ in long, to pass 50 hr salt spray test, OAK type 61890K2, WPD Part No. SWR068-001	V MULTIPLIER

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
S-2		SWITCH, Rotary, sectional type, 1 sect, 3 positions max possible number, one momentary position, non-pile-up type, 2 moving contacts, 2 poles, 3 throws, not electrically rated, non-shorting type contacts, 11/16 lg x 1¼ in wide x 15/16 in high, mtd by bushing, ⅜-32 x ⅜ in long, rd shaft, ¼ in dia x 11/16 in lg; to pass 50 hr salt spray test, OAK type 61896-F1, WPD Part No. SWR066-001	CAL switch
S-3		SWITCH, Slide, SPDT, 0.75 amp, 125V, metal case, 1 13/32 in lg x 35/64 in wide x 5/16 in thk, slide bar actuator, 1 1/32 in lg x ¼ in wide x 5/16 in thk, locking action, surface mtg, two 0.136 in dia mtg holes spaced 1⅛ in C to C, WCO type SW724, WPD Part No. SSA002-001, P/O TB-4	NORMAL V DIRECT switch
S-4		SWITCH, Thermostatic, SPST, 1 circuit contacts close on temp increase, 50 deg C closing temp, 30 deg C opening temp, ±3 deg C tolerance, bimetal element, 7 amp, 115V AC, ⅝ in dia, 7/32 in thk, STMF type M, WPD Part No. SYA004-001, P/O TB-7	Ventilation fan control
S-5		SWITCH, Toggle, DPDT, three positions, ON-OFF-ON, 6 amp, 125 V max, 15/16 in long x ¾ in wide x 13/16 in high bat type handle, 11/16 in long, mtd by bushing, 15/32-32 x 15/32 in long, JAN ST52P, spec JAN-S-23	HEATER OFF POWER switch
S-6		SWITCH, Interlock, 6 amp, 125V, 3 amp 250V, SPST, momentary contact, normally closed, bakelite case, 1¼ in lg x ⅝ in wide x 63/64 in deep, excluding terminals, mtd by bushing, 15/32-32 x ½ in long, materials and finishes per JAN-S-23, CUT type 8911K53, WPD Part No. SIA003-001, P/O TB-4	Ventilation door interlock
S-7		SWITCH, Interlock, 6 amp, 125V, 3 amp, 250V, SPST, momentary contact, normally open, bakelite case, 1 3/32 in lg x ⅝ in wide x 63/64 in deep, excluding terminals, mtd by bushing, 15/32-32 x ½ in long, materials and finish per JAN-S-23, CUT type 8911K52, WPD Part No. SIA004-001	Chassis safety interlock
S-8		SWITCH, Rotary, sectional type, 1 sect, 3 positions, 1 pole, three throws, ¾ in lg x 1 13/32 in wide x 1 17/32 in high, mtd by bushing, ⅜-32 in x ¼ in lg, shaft, rd slotted, ½ in lg ¼ in dia, to pass 50 hr salt spray test, OAK type 61891-K1, WPD Part No. SWR067-001	Line voltage adjust
S-9	3	SWITCH, Rotary, part of R-98	SCALE ILLUMINATION
S-10		SWITCH, Rotary, sectional type, 1 sect, 4 pos, max possible, non-pile-up type, one moving 5 fixed contacts, one pole, 4 throws, not electrically rated, shorting type, 13/16 in lg x 1 13/32 in wide x 1 17/32 in high, mtd by bushing, ⅜-32 x ⅜ in lg, shaft, rd, ⅞ in lg, ¼ in dia, to pass 50 hr salt spray test, OAK type 61892-K1, WPD Part No. SWR070-001	SYNC INPUT selector
S-11		SWITCH, Rotary, sectional type, 3 sect, 6 positions, max possible number, non-pile-up type, 6 circuits, 2 dummy terminals, 6 throws, not electrically rated, non-shorting type contacts, brass contacts, silver plated, plastic section insulation, 2 7/16 in lg x 1 13/32 in wide x 1 17/32 in high mtd by bushing, ⅜-32 x ⅜ in lg, rd shaft, ¼ in dia, ⅞ in lg, to pass 50 hr salt spray test, OAK type 61897-K3, WPD Part No. SWR063-001, P/O Z-3	SWEEP RANGE selector
S-12	3	SWITCH, Rotary, part of R-126	Selects fixed pulse trigger or variable SWEEP STABILITY control
S-13		SWITCH, Rotary, sectional type, 4 sect, 6 positions, max possible number, non-pile-up type, 6 circuits, 6 dummy terminals, non-shorting type contacts, brass, silver plated, plastic section insulation, 3 in long x 1 13/32 in wide x 1 17/32 in high, mtd by bushing, ⅜-32 x ⅜ in long, rd shaft, ¼ in dia, ⅞ in long, to pass 50 hr salt spray test, OAK type 61895-K4, WPD Part No. SWR065-001, P/O Z-2	MARKER μS selector

Note: 3. For reference only

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
S-14		SWITCH, Rotary, sectional type, 2 sect, 6 positions, max possible number, non-pile-up type, 2 circuits, 9 dummy terminals, 6 throws, not electrically rated, non-shorting type contacts, brass contacts, silver plated, plastic section insulation, $1\frac{19}{32}$ in lg x $1\frac{13}{32}$ in wide x $1\frac{17}{32}$ in high, mtd by bushing, $\frac{3}{8}$-32 x $\frac{3}{8}$ in lg, rd shaft, $\frac{1}{4}$ in dia, $\frac{7}{8}$ in long, to pass 50 hr salt spray test, OAK type 61894-K2, WPD Part No. SWR064-001, P/O Z-4	TRIGGER PPS selector
S-15		SWITCH, Rotary, sectional type, 1 sect, 2 pos, max possible number, non-pile-up type, 3 circuits, 2 throws, not electrically rated, non-shorting type contacts, brass contacts, silver plated, plastic section insulation, $\frac{3}{4}$ in lg x $1\frac{13}{32}$ in wide x $1\frac{17}{32}$ in high, mtd by bushing, $\frac{3}{8}$-32 x $\frac{3}{8}$ in lg, rd shaft, $\frac{1}{4}$ in dia x $3\frac{1}{2}$ in lg, to pass 50 hr salt spray test, OAK type 61893-K1, WPD Part No. SWR062-001	SWEEP DELAY IN-OUT switch
T-1		TRANSFORMER, Power, Step-down and Step-up, open frame, primary: 105, 115, 125V, 50 to 400 cycles, single phase, 8 secondary windings: No. 1: 490V, center tapped, 0.270 amp, 800V insulation, No. 2: 270V, 0.025 amp, 800V insulation, No. 3: 1300V, 0.7 MA 3600V insulation, No. 4: 1.125V, 0.3 amp, 3600V insulation, No. 5: 1.125V, 0.3 amp, 3400V insulation, No. 6: 14.5V, 0.125 amp, No. 7: 12.6V center tapped, 5.6 amp, No. 8: 6.3V, 0.9 amp, 3200V insulation, air cooled, Stypol impregnation, dim MVCA Ref Dwg GRP12, $4\frac{5}{8}$ in lg, 4 in wide, $4\frac{5}{8}$ in high, 21 terminals, turret type solder lugs, four $\frac{7}{32}$ in dia mtg holes, $3\frac{3}{4}$ in x $3\frac{13}{16}$ in mtg C, internal shielding, WPD Part No. LPU015-A01	Power supply transformer
T-2		TRANSFORMER, Pulse, Blocking Oscillator Type, impedance: primary not rated, secondaries not rated, DC resistance: primary, 3.9 ohms, sec No. 1, 4.1 ohms, sec No. 2, 4.5 ohms, operating voltage and current data: primary not rated, secondaries not rated, insulation test voltage not rated, metal case, hermetically sealed type, 2 lg x 1 in wide x $2\frac{7}{32}$ in deep, mtd by two 6-32 x $\frac{9}{16}$ in studs spaced $\frac{9}{16}$ in C/C, WPD Part No. LZP001-A01	Trigger generator pulse transformer
TB-1	2	TERMINAL BOARD, Natural Paper Base XXXP bakelite, W/O terminals, $2\frac{1}{2}$ in lg x $2\frac{5}{16}$ in wide x $\frac{1}{8}$ in thk, four 0.128 in dia mtg holes, spaced 2.125 in C/C and 1.875 in C/C, imprinted per Waterman Dwg IPB167-001, WPD Part No. IPB167-001, P/O Z-1	Mounting for C-1, C-2, C-3, C-4, C-5
TB-2	5	SUBASSEMBLY: C/O Terminal Board Natural Paper Base XXXP bakelite, with turret type terminals, $5\frac{9}{16}$ in lg x $2\frac{3}{4}$ in wide x $\frac{1}{8}$ in thk, bracket mtd, $5\frac{1}{4}$ in mtg/C, imprinted per Waterman Dwg IPB173-001, contains R-17, R-19, R-20, R-21, R-22, R-31, R-32, R-44, R-48, R-49, C-15, C-19, C-20, C-21, includes two mtg brackets, WPD Part No. DEC038-A01	Component mounting for vertical channel
TB-3	5	SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, with 8 split turret terminals, $2\frac{3}{8}$ in lg x $1\frac{7}{16}$ in wide x $\frac{1}{8}$ in thk, two mtg spacers integrally mtd to board, 2 in mtg/C, imprinted per Waterman Dwg IPB165-001, contains R-39, R-40, R-46, R-47, WPD Part No. DEB060-A01	Component mounting for vertical output amplifier plate load resistors
TB-4	5	SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, W/O terminals, $2\frac{3}{4}$ in lg x 2 in wide x $\frac{1}{8}$ in thk, two 0.156 in dia mtg holes spaced 2.250 in C/C, imprinted per Waterman Dwg IPB168-001, contains S-3, S-6, E-2, E-3, WPD Part No. DEB064-A01	Mounting for E-2, E-3, S-3 and S-6
TB-5	5	SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, with turret terminals, $2\frac{9}{16}$ in lg x 2 in wide x $\frac{1}{8}$ in thk, two mtg brackets integrally mtd to board, one in mtg/C, imprinted per Waterman Dwg IPB166-001, contains C-47, C-49, C-51, C-95, C-96, R-99, R-189, WPD Part No. DEB061-A01	Component mounting for SYNC and HORIZONTAL inputs

Note: 2. Shop manufacture
5. Assemble from component parts

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
TB-6	5	SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, with turret terminals, 2⅛ in lg x 2⅛ in wide x ⅛ in thk, two mtg brackets attached, 1¼ in mtg/C, imprinted per Waterman Dwg IPB169-001, contains C-52, C-86, R-112, R-113, R-115, R-172, R-175, R-178, R-184, WPD Part No. DEB062-A01	Component mounting for SYNC and SWEEP circuits
TB-7	5	SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, with turret terminals, 6⅜ lg x 3 in wide x ⅛ in thk, bracket mtd, 6 in mtg/C, imprinted per Waterman Dwg IPB174-001, contains: R-116, R-117, R-118, R-121, R-122, R-123, R-124, R-128, R-169, R-170, R-173, R-176, R-177, R-179, R-180, R-185, R-191, R-192, R-197, R-198, R-199, R-200, R-201, R-202, R-203, R-204, C-61, C-63, C-82, C-84, C-85, C-93, C-100, L-9, L-13, L-14, S-4, with two brackets, WPD Part No. DED025-A01	Component mounting for GATE, SWEEP, SYNC and HORIZONTAL output circuits
TB-8	2	TERMINAL BOARD, Melamine, 15 phosphor bronze gold plated socket type contacts, solder pots for No. 18AWG connectors, 2 19/32 in lg x ½ in wide x 27/32 in overall depth, 2 mtg holes spaced 2.218 in C/C, EBY type 1000F15, WPD Part No. ECC010-001	Interconnection terminals for upper right hand chassis
TB-9		Same as TB-8	Interconnection terminals for upper left hand chassis
TB-10	5	SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, with turret terminals, 4½ in lg x 3⅛ in wide x ⅛ in thk, four 0.161 in dia mtg holes, spaced 3 13/16 x 2⅝ in, imprinted per Waterman Dwg IPB170-001, contains R-53, R-54, R-55, R-56, R-57, R-59, R-60, R-61, R-63, R-64, R-94, R-217, C-22, C-23, C-24, C-25, C-67, TB-11, two spacers integrally mtd to board for mtg TB-11, WPD Part No. DED027-A01	Component mounting for DISPLAY CHANNEL
TB-11	2	TERMINAL BOARD, Melamine, 7 phosphor bronze gold plated socket type contacts, solder pots for No. 18AWG connectors, 1⅝ in lg x ½ in wide x 27/32 in deep overall, 2 mtg holes spaced 1.250 in C/C, EBY type 1000-F7, WPD Part No. ECC009-001, P/O TB-10	Interconnection terminals for DISPLAY CHANNEL
TB-12	5	SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, with turret terminals, 4 in lg x 2¾ in wide x ⅛ in thk, bracket mtd, 3.625 in mtg/C, imprinted per Waterman Dwg IPB-164-001, contains: R-65, R-129, R-131, R-133, R-134, R-137, R-148, R-149, R-151, R-152, R-153, R-154, R-155, R-156, R-157, L-11, L-12, C-78, C-80, with two mtg brackets, WPD Part No. DEC034-A01	Component mounting for TRIGGER and MARKER generators
TB-13	5	SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, with turret terminals, 4 11/16 in lg x 2 in wide x ⅛ in thk, bracket mtd, 4.375 in mtg/C, imprinted per Waterman Dwg IPB171-001, contains: C-28, C-29, C-30, C-31, C-32, C-33, C-34, C-35, R-68, R-69, R-70, R-71, R-72, R-73, R-74, R-75, R-76, R-77, R-83, R-84, R-85, R-86, R-87, R-88, R-89, R-90, R-207, R-208, with two mtg brackets, WPD Part No. DEC039-A01	Component mounting for CAL voltage generator and low voltage rectifier
TB-14	5	SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, with turret terminals, 5¼ in lg x 3¼ in wide x ⅛ in thk, four 0.161 in dia mtg holes spaced 2.500 x 4.625 in, imprinted per Waterman Dwg IPB163-001, contains: C-39, C-40, C-41, C-42, C-43, R-81, R-82, R-91, R-92, R-97, WPD Part No. DMC060-A01	Component mounting for low voltage power supply filter circuits
TB-15	5	SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, with turret terminals, 4½ in lg x 3⅛ in wide x ⅛ in thk, four integrally mtd spacers for mtg, imprinted per Waterman Dwg IPB172-001, contains: C-44, C-45, C-46, R-93, R-95, R-96, includes six integrally mtd capacitor mtg brackets, WPD Part No. DEB065-A01	Component mounting for high voltage supply filter circuits

Note: 2. Shop manufacture
5. Assemble from component parts

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
TB-16		SUBASSEMBLY: C/O Terminal Board, Natural Paper Base XXXP bakelite, with turret terminals, 2¾ in long x 1¾ in wide x ⅛ in thick, 3 integrally mounted 6-32 thd. tapped spacers for mounting, imprinted per WPD Dwg IPB191, contains C-16, L-16, R-24, MP-13 clamp, WPD Dwg DEB073-A01	Component mounting for DL-1 input matching impedance
V-1		ELECTRON TUBE, pentode, JAN 6AH6	Vertical preamplifier
V-2A, B		ELECTRON TUBE, twin triode, JAN 12AU7	Internal sync take-off and delay line driver
V-3		Same as V-1	Vertical intermediate amplifier
V-4		ELECTRON TUBE, Pentode, 7 Pin, JAN 6AN5WA	Vertical grid driven output amplifier
V-5		Same as V-4	Vertical cathode driven output amplifier
V-6		ELECTRON TUBE, Cathode Ray, JAN 3JP1	Cathode ray tube
V-7A, B		Same as V-2A, B	Calibration generator grid driven multivibrator
V-8		ELECTRON TUBE, Glass Envelope, twin diode, RMA type T-6½, 9 pin, located on bottom, reliable series type 6203	Plate supply rectifier
V-9		Same as V-8	Plate supply rectifier
V-10		Same as V-8	Plate supply rectifier
V-11		Same as V-8	Plate supply rectifier
V-12		ELECTRON TUBE, Glass Envelope, rectifier, RMA type T-6½, 9 pin, located on bottom, 1V2	Positive high voltage rectifier
V-13		Same as V-12	Negative high voltage rectifier
V-14A, B		ELECTRON TUBE, Glass Envelope, twin triode, RMA type T-6½, 9 pin, located on bottom, JAN 12AT7WA	A-SYNC cathode follower B-SYNC intermediate amplifier and phase inverter
V-15A, B		ELECTRON TUBE, Glass Envelope, twin diode, RMA type T-5½, 7 pin, located on bottom, JAN 5726	A-SYNC injection and isolation diode B-SYNC DC clamp
V-16A, B		Same as V-14A, B	A-Gate generator B-Parallel trigger for SYNC tube
V-17A, B		Same as V-2A, B	A-Gate generator cathode follower B-Gate generator pulse amplifier
V-18A, B		Same as V-14A, B	A-Marker generator injection and isolation diode B-Marker generator keying tube
V-19		ELECTRON TUBE, Glass Envelope, voltage regulator, RMA type T-5½, 7 pin, located on bottom, JAN 0A2WA	+150 voltage regulator
V-20		ELECTRON TUBE, Glass Envelope, triode RMA type T-5½, 7 pin, located on bottom, JAN 6135	Marker generator DC setter
V-21A, B		Same as V-14A, B	A-Marker pulse generator B-Marker pulse amplifier
V-22		Same as V-1	Marker output amplifier
V-23A, B		Same as V-2A, B	Trigger generator blocking tube oscillator
V-24		Same as V-20	Intensity gate amplifier
V-25A, B		Same as V-15A, B	A-Sweep delay generator DC clamp B-Sweep generator and intensity gate limiter

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
V-26A, B		Same as V-2A, B	A-Sweep generator cathode follower and bootstrap B-Sweep generator switch tube
V-27A, B		Same as V-14A, B	Sweep delay cathode driven and grid driven amplifiers
V-28A, B		Same as V-2A, B	A-Horizontal DC clamp B-Horizontal amplifier
V-29A, B		Same as V-2A, B	A-Horizontal grid driven output amplifier B-Horizontal cathode driven output amplifier
XDS-1		LAMPHOLDER, Accommodates min bayonet base lamp, not electrically rated, 2 5/32 in lg, two solder lug terminals at rear, panel mtd, requires one mtg hole 11/16 in dia, includes 1/2 in dia lens, convex, clear, frosted on back; overall finish black oxidized, DMC type 100, MIL-CLEAR-SFB, WPD Part No. ESP062-001	Socket for DS-1
XDS-1A	4	LENS, Clear, Convex, Frosted, DMC type 25 clear	Lens for XDS-1
XDS-2		Same as XDS-1 except red lens, DMC type 100, MIL-RUBY-SFB, WPD Part No. ESP062-002	Socket for DS-2
XDS-2A	4	LENS, Ruby, Convex, Frosted, DMC type 25 RUBY	Lens for XDS-2
XDS-3		LAMPHOLDER, Accommodates min bayonet base lamp, not electrically rated, steel, cad plated frame, 1 1/4 in lg x 3/4 in wide x 1 in high, two solder lug terminals, clip mtd on CRT shield DLC type 702, WPD Part No. ESP060-001	Socket for DS-3
XDS-4		Same as XDS-3	Socket for DS-4
XF-1		FUSEHOLDER, Extractor Post Type, 250V 15 amp, holds one cartridge type fuse ferrule terminals, 1 1/4 in lg x 1/4 in dia, plastic body, brass tinned contacts, 2 3/16 in lg x 11/16 in dia, two solder lug terminals, panel mtd on 1/2 in dia mtg hole, LTF type 342003, WPD Part No. EFC002-001	Socket for F-1
XF-2		Same as XF-1	Socket for F-2
XF-3		Same as XF-1, except holds spare fuse	Socket for F-3
XF-4		Same as XF-1, except holds spare fuse	Socket for F-4
XV-1		SOCKET, Electron Tube, min 7 pin contact configuration, no contacts missing, copper base alloy contacts, silver plated, hot tin dipped, molded body, low loss phenolic, 1 3/32 in lg x 51/64 in wide x 1 5/8 in deep, solder tab type contact terminals, body accommodation hole required, plain rd, 0.646 in dia, two 1/8 in dia mtg holes spaced 7/8 in C/C, provisions for mtg electron tube shield not provided, electron tube retaining device not included, six turret type solder lug terminals on circular XXXP bakelite board, mtd integrally to socket by 0.195 in dia metal rod, EBY type 9737-59, WPD Part No. ESR158-001	Socket for V-1
XV-2		SOCKET, Electron Tube, noval contact, configuration, no contacts missing, copper base alloy contacts, silver plated, hot tin dipped, molded body, low loss phenolic, 1 3/8 in lg x 15/16 in wide x 11/16 in deep, solder tab type contact terminals, body accommodation hole required, plain rd, 3/4 in dia, two 1/8 in dia mtg holes spaced 1 1/8 in C/C, provisions for mtg electron tube shield not provided, with center shield, electron tube retaining device not included, EBY type 9713-20, WPD Part No. ESR151-007	Socket for V-2
XV-3		Same as XV-1	Socket for V-3
XV-4		Same as XV-1	Socket for V-4
XV-5		Same as XV-1	Socket for V-5

Note: 4. Replace with the substitute part having the stock number listed in Table 8-3

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
XV-6		SOCKET, Electron Tube, diheptal contact configuration, contacts No. 4, 6, 12, 13 missing, copper base alloy contacts, silver plated, molded body, mica filled phenolic, 2 7/32 in dia x 4 7/64 in deep, solder tab type contact terminal, tube mtd type socket, provisions for mtg electron tube shield not provided, electron tube retaining device not included, EBY type 9709-32, WPD Part No. ESN003-001	Socket for V-6
XV-7		Same as XV-2	Socket for V-7
XV-8		Same as XV-2	Socket for V-8
XV-9		Same as XV-2	Socket for V-9
XV-10		Same as XV-2	Socket for V-10
XV-11		Same as XV-2	Socket for V-11
XV-12		SOCKET, Electron Tube, same as XV-2 except less center shield, EBY type 9713-100, WPD Part No. ESR151-008	Socket for V-12
XV-13		Same as XV-12	Socket for V-13
XV-14		SOCKET, Electron Tube, noval contact configuration, no contacts missing, copper base alloy contacts, silver plated hot tin dipped, molded body, low loss phenolic, 1 7/16 in lg x 1 5/16 in wide x 1 5/8 in deep, solder tab type terminals, body accommodation hole required, plain rd, 3/4 in dia, two 1/8 in dia mtg holes spaced 1 1/8 in C/C, provisions for mtg electron tube shield not provided, electron tube retaining device not included, six turret type solder lug terminals on circular XXXP bakelite board mtd integrally to socket by 0.195 in dia metal rod, EBY type 9737-60, WPD Part No. ESR-159-001	Socket for V-14
XV-15		SOCKET, Electron Tube, min 7 pin contact configuration, no contacts missing, copper base alloy contacts, silver plated, hot tin dipped, molded body, low loss phenolic, 1 3/32 in lg x 5 1/64 in wide x 11/16 in deep, solder tab type terminals, body accommodation hole required, plain rd, 0.646 in dia, two 1/8 in dia mtg holes spaced 7/8 in C/C, provisions for mtg electron tube shield not provided, W/centershield, electron tube retaining device not included, EBY type 9180, WPD Part No. ESR104-008	Socket for V-15
XV-16		Same as XV-2	Socket for V-16
XV-17		Same as XV-2	Socket for V-17
XV-18		Same as XV-2	Socket for V-18
XV-19		Same as XV-15	Socket for V-19
XV-20		Same as XV-15	Socket for V-20
XV-21		Same as XV-12	Socket for V-21
XV-22		Same as XV-15	Socket for V-22
XV-23		Same as XV-2	Socket for V-23
XV-24		Same as XV-15	Socket for V-24
XV-25		Same as XV-15	Socket for V-25
XV-26		Same as XV-2	Socket for V-26
XV-27		Same as XV-2	Socket for V-27
XV-28		Same as XV-2	Socket for V-28
XV-29		Same as XV-2	Socket for V-29
Z-1		SUBASSEMBLY: Attenuator, Variable, step by step, frequency compensated, resistive capacitive type, consists of: C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, S1, TB1, WPD Part No. DED023-A01	Attenuates V-input signal

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
Z-2		SUBASSEMBLY: Marker Generator Selector Switch, consists of: L10, S13, C65, C66, C68, C69, C70, C72, C73, C74, C75, C76, C77, R138, R139, R140, R143, R144, R145, R146, R147, WPD Part No. DED028-A01	Selects marker frequency
Z-3		SUBASSEMBLY: Sweep Generator Selector Switch, c/o: C54, C55, C56, C57, C58, C87, C88, C89, C90, R119, S11, WPD Part No. DED026-A01	Selects nominal sweep time
Z-4		SUBASSEMBLY: Trigger Generator Selector Switch, c/o: C79, C81, R158, R159, R160, R161, R162, R163, R164, R165, R166, R167, S14, WPD Part No. DEC040-A01	Selects trigger rate
		ACCESSORY PART OF AN/USM-24C	
A-301	1	COVER, Combination, case, alum, gray enamel fin, 15 in high x 17⅛ in wide x 2 25/32 in deep, mtd on case with 4 clasps, accessory holding tray riveted to inside surface, plastic schematic mtd on inside surface, CW-362/USM-24C, WPD Part No. DMD053-A01, P/O CAGX Oscilloscope AN/USM-24C	Cover for combination case of oscilloscope AN/USM-24C
C-301	3	CAPACITOR, Variable, Ceramic Dielectric, slug type, 3 uuf min, 11 uuf max 500 VDCW, screwdriver slot adjustment, ⅝ in lg x 0.215 in dia, ERC type 3139 WPD Part No. CZB002-003, P/O test lead, CG-883A/USM-24	Part of high frequency compensation in test lead CG-883A/USM-24
C-302	3	Same as C-101, P/O test lead, CG-1277/USM-24C	Blocking capacitor for test lead CG-1277/USM-24C
C-303	3	Same as C-101	Plate by-pass capacitor for V-301
C-304		CAPACITOR, Fixed, Mica Dielectric, 500 VDCW, 5 uuf ±10%, molded body, ½ in lg x 9/32 in wide x 3/16 thk, axial leads term mtd, EMM type CM15B050K, WPD Part No. CZB004-012, P/O test lead, CG-883A/USM-24C	Part of high frequency compensation in test lead CG-883A/-USM-24
E-301		CONNECTOR, Adapter, BNC to UHF, UG-255/U, spec Navy Dwg RE49F378	Connect from UHF male to BNC female
E-302		CONNECTOR, Adapter, binding post, UG-924/U, spec MIL-O-1548 (ships), WPD Part No. DFI006-A01	For connecting single wire leads to oscilloscope
E-303		CONNECTOR, Adapter, Tee, UG-274/U, spec MIL-C-3608	Connects from 2BNC male to oscilloscope
E-304		CONNECTOR, Adapter, BNC to UHF, UG-273/U, spec Navy Dwg RE49F389	Connect from UHF female to BNC male
E-305		CONNECTOR, Adapter, N to BNC, UG-201A/U, spec SIG-C Dwg SC-D-72309	Connects N female to BNC male
E-306		CONNECTOR, Adapter, N to BNC, UG-349A/U, spec SIG-C Dwg SC-D-72331	Connects N male to BNC female
H-301		WRENCH, Socket Head Screw, hex type, 1/16 in A/F, L-type handle, 1 13/16 in lg overall, ALN MFG, WPD Part No. TWA004-002	Fits No. 6 socket head set screw
H-302		WRENCH, Socket Head Screw, hex type, 5/64 in A/F, L-type handle, 1 15/16 in lg overall, ALN MFG, WPD Part No. TWA004-003	Fits No. 8 socket head set screw
H-303		WRENCH, Socket Head Screw, hex type, 3/64 in A/F, L-type handle, 1 13/16 in lg overall, ALN MFG, WPD Part No. TWA004-001	Fits No. 4 socket head set screw
H-304		WRENCH, Spanner, Face, Fixed, type, seamless cold rolled steel tubing, double head, one end fits 13/32 in dia of circle, 2 pins, 3/32 in wide, 3/64 in lg, other end fits 7/32 in dia of circle, 2 pins, 0.050 in wide, 3/64 in lg, 4⅛ lg overall, cad plate finish, CAGX Part No. TWA003-002	Fits ⅜-32 control mtg nuts and nuts on test leads
L-301		COIL, Radio Frequency, 1 winding, single layer wound, 1.9 microhenry at 9.5 MC, bakelite core, not adjustable not cased, ½ in lg x 5/32 in dia, two axial leads, Q of 40 at 9.5 MC, WPD Part No. LLU-020-001, P/O test lead, CG-1277/USM-24C	Cathode peaking for V-301

Note: 1. Low Failure Items—If required requisition from ESO, referencing NAVSHIPS 900, 180A
3. For reference only

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
P-301		CONNECTOR, Plug, Electrical, UG-260/U, spec MIL-C-3608, IPC type 3100, P/O test lead, CG-1277/USM-24C	Connects test lead CG-1277/USM-24C to oscilloscope V INPUT connector
P-302		CONNECTOR, Plug, Electrical, and clamp cable, AN 3106A-14S-7P Clamp AN 3057-6, spec MIL-C-5015, P/O test lead, CG-1277/USM-24C	Connects test lead CG-1277/USM-24C to oscilloscope probe power connector
P-303		Same as P-301, P/O test lead, CG-883A/USM-24	Connects test lead CG-883A/USM-24 to oscilloscope
P-304		CONNECTOR, Plug, Electrical, UG-88/U, spec MIL-C-3608, AMP type 1200, P/O test lead, CG-409/U (8'0")	Connects test lead CG-409/U to external circuits
P-305		Same as P-304, P/O test lead, CG-409/U (8'0")	Connects test lead CG-409/U to oscilloscope
P-306		CONNECTOR, Plug, Electrical, 3 contacts, 2 female, semi-circular, one female, rd, 15 amp @125V, 10 amp @250V, plastic dielectric, straight shape, 1¼ in lg x 1$\frac{3}{32}$ in dia, polarized, locking type, twist type, 0.421 in dia, max cable accommodated, W/clamp, HAW Part No. 7484, P/O Power Cable CX-3092/USM-24C	Connects power cable CX-3092-/USM-24C to oscilloscope power jack
R-301		RESISTOR, Fixed, Film, 2.7 meg ±1%, ½W, JAN RN20X2704F, spec MIL-R-10509A, P/O test lead, CG-883A/USM-24	Part of 10:1 attenuation in test lead CG-883A/USM-24
R-302		Same as R-105, P/O test lead, CG-1277/USM-24C	Grid parasitic suppressor for V-301
R-303		Same as R-34, P/O test lead, CG-1277/USM-24C	Grid resistor for V-301
R-304		Same as R-148, P/O test lead, CG-1277/USM-24C	Cathode resistor for V-301
R-305		Same as R-105, P/O test lead, CG-1277/USM-24C	Ground isolation
V-301		ELECTRON TUBE, Subminiature, Triode, JAN-5719, P/O test lead CG-1277/USM-24C	Impedance converter for test lead CG-1277/USM-24C
W-301		CABLE ASSEMBLY, Radio Frequency, c/o approx 8 ft coaxial cable, RG58/U, terminated at one end with P-304, other end terminated with P-305, CAGX Part No. DFI008-A02, U/W CAGX oscilloscope AN/USM-24C, CG-409/U (8'0")	For interconnection between the oscilloscope and test or signal points on other equipment
W-302		CABLE ASSEMBLY, Power, Electrical, c/o approx 6 ft cable, power, electrical, 3 conductor, type SV cable, No. 18AWG stranded, tinned copper conductors, P-306 at one end, molded parallel blade connector with ground lead at other end, CAGX Part No. DFI020-A01, CX-3092/USM-24C	Power cable for connecting line supply voltage to oscilloscope
W-303		LEAD, Test, c/o 52 in of cable, RG-62/U, terminated at one end with P-303, other end terminated with special probe fitted with grounding lead and probe tip. Probe contains C301, C304, R301, CG-883A/USM-24, CAGX Part No. DFI021-A01	Provides an oscilloscope signal input of low shunt capacity for observation of and synchronizing from high impedance circuitry. Also provides additional signal attenuation by factor of ten to one for observation of high amplitude signals

TABLE 8—1. MAINTENANCE PARTS LIST—Continued

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
W-304		LEAD, Test, consists of junction box and three cables, cable data (test prod to junction box): total of 7 conductors, 5 stranded conductors, copper, No. 22AWG vinyl plastic insulation, color coded red, black, brown, blue, yellow, one core conductor, copper, No. 22AWG, solid, polyethylene dielectric, plain copper braid shield jute filler between stranded conductors, cotton insulator black vinyl plastic jacket overall, 0.032 in thk min, 0.365 in max OD, Phalo Plastics type 14765, 32 in lg one end terminated in junction box, other end terminated with low capacity probe, cable data (junction box to signal output): 4½ in RG-62/U, one end terminated in junction box, other end terminated with P-301 Cable data (junction box to power input): 3 conductors, stranded, copper, No. 20AWG, cotton wraps, rubber, rayon braid, tinned copper braid shield, black rubber jacket color coded: black, red, white, Belden Mfg Co. type 8423, 5 in lg one end terminated in junction box, other end terminated with P-302, 41 in overall length of test lead assembly Junction box contains: R-304, R-305, Probe contains: C-302, C-303, R-302, R-303, L-301, and V-301, CG-1277/USM-24C, CAGX Part No. DFI019-A01, U/W CAGX oscilloscope AN/USM-24C	Provides the oscilloscope with a low shunt capacity input for testing high frequency circuits in which the voltage does not exceed approx 2 volts peak

*TABLE 8—2A. PARTS SUPPLIED WITH EQUIPMENT WHEN EQUIPMENT SPARES ARE ORDERED

REF. DESIG.	BOX NO.	QUANTITY
C-13	2	1
C-14A/B	2	1
C-35	2	1
C-44	2	1
C-50A, B, C	2	1
C-58	2	1
C-59	2	1
C-60A, B, C	2	1
C-64	2	1
C-71A, B, C	2	1
C-82	2	1
C-83	2	1
C-90	2	1
C-91	2	1
C-99	2	1
C-103A/B	2	1
CR-1	2	1
CR-2	2	1
E-6	2	1
E-9	2	1
FL-1	2	1
L-2	2	1
L-8	2	1
L-9	2	1
L-10	2	1
L-11	2	1
L-15	2	1
L-17	2	1

REF. DESIG.	BOX NO.	QUANTITY
R-23	2	1
R-25	2	1
R-50	2	1
R-51A/B	2	1
R-66	2	1
R-78	2	1
R-80	2	1
R-98	2	1
R-106	2	1
R-120A/B	2	1
R-126	2	1
R-127	2	1
R-130	2	1
R-135	2	1
R-141	2	1
R-168	2	1
R-187	2	1
R-193	2	1
R-196	2	1
S-1	2	1
S-2	2	1
S-8	2	1
S-10	2	1
S-11	2	1
S-13	2	1
S-14	2	1
S-15	2	1
V-8	2	2

**TABLE 8—2B. PARTS SUPPLIED WITH EQUIPMENT WHEN EQUIPMENT SPARES ARE ORDERED

REF. DESIG.	BOX NO.	QUANTITY
DS-1	2	10
E-6	2	1
E-9	2	2
F-1	2	8
J-1	2	1
V-1	2	1
V-2	2	1
V-4	2	1

REF. DESIG.	BOX NO.	QUANTITY
V-6	2	1
V-8	2	2
V-12	2	1
V-14	2	1
V-15A, B	2	1
V-19	2	1
V-20	2	1
V-301	2	1

TABLE 8—3. STOCK NUMBER IDENTIFICATION

REF. DESIG.	STOCK NUMBER			
	FEDERAL	STANDARD NAVY	SIGNAL CORPS	AIR FORCE
A-1				
A-2		Same as A-1		
A-3		Same as A-1		
A-4		Same as A-1		
A-5		Not used		
A-6		Not used		4BAA-219577-28
B-1				
B-1A		N17-1019005-5174	6Z7670	
B-1B		N16-H-800001-482	3H2549-67	
B-1C		N17-M059604-6501	3H3100-113	
C-1		N16-C-64133-6581	3D9045V-15	
C-2		Same as C-1		
C-3		Same as C-1		
C-4		Same as C-1		
C-5		Same as C-1		
C-6		N16-C-33274-5548	3K3582232	
C-7		N16-C-32140-4684	3K3027222	3330-376132-150
C-8		N16-C-30742-4484	3K3082122	3330-376143-215
C-9		N16-C-29608-2196	3K2027122	3330-376021-000
C-10		N16-C-27761-7196	3K2056022	3330-376038-300
C-11		*N16-C-45805-6356		3330-057252821
C-12		*N16-C-29133-3831	3K1518122	
C-13		N16-C-45805-8768	3DA100-1328	
C-14A, B		N16-C-21833-8926	3DB70-4	3330-055725321
C-15		N16-C-45803-1984		3330-057252801
C-16		N16-C-20283-9341	3DB125-8	3330-055725-007
C-17		*N16-C-44111-2705		3330-057252861
C-18		Same as C-13		
C-19		Same as C-15		
C-20		Same as C-11		
C-21		Same as C-11		
C-22		N16-C-55870-1118		
C-23		N16-C-55765-1514	3DA5-239	3330-NSL
C-24		Same as C-15		
C-25		N16-C-55929-7300	3DA2-224	3330-05785-0000
C-26A, B, C		N16-C-22490-1201	3DB15-72	3330-NSL
C-27A, B, C		N16-C-22483-4325	3DB20-152	3330-NSL
C-28		N16-C-29613-2676	3K2027121	
C-29		Same as C-17		
C-30		N16-C-26605-9557	3K1518021	3330-0559050340
C-31		N16-C-29476-3031		3330-056200914
C-32		Same as C-31		
C-33		Same as C-30		
C-34		Same as C-17		
C-35		N16-C-31354-1760	3DA1.300-3	3330-050200919
C-36		*N16-C-31085-3596		
C-37		*N16-C-20118-9970		
C-38		Same as C-36		
C-39		N16-C-20456-5881	3DB200-22	3330-055725360
C-40A, B		N16-C-21833-7142	3DB20-155	3330-NSL
C-41		N16-C-19715-7901	3DB20-154	3330-055725308
C-42		N16-C-19865-7176	3DB30-69	3330-NSL
C-43		N16-C-19717-2201	3DB20-153	3330-NSL
C-44		N16-C-55914-4096	3DA100-1330	
C-45		Same as C-25		
C-46		N16-C-55914-1143		
C-47		Same as C-1		
C-48		N16-C-29718-7276	3K2033121	
C-49		N16-C-42765-5354		3330-057252799
C-50A, B, C		N16-C-22485-3106	3DB10-318	3330-055725362
C-51		Same as C-49		
C-52		Same as C-49		
C-53		N16-C-30188-4996	3K2051122	
C-54		Same as C-1		
C-55		N16-C-27186-4876	3K2033021	
C-56		N16-C-30373-2192	3K2562122	

*Asterisks apply to replacement items which differ from the original item supplied in the equipment.

TABLE 8—3. STOCK NUMBER IDENTIFICATION—Continued

REF. DESIG.	STOCK NUMBER			
	FEDERAL	STANDARD NAVY	SIGNAL CORPS	AIR FORCE
C-57		N16-C-32905-4328	3K3562222	
C-58		N16-C-44679-8210	3DA62-1	3330-057252800
C-59		N16-C-47628-2237	3DA600-25	
C-60A, B, C		N16-C-22485-3170	3D9030-114	3330-055225329
C-61		N16-C-26843-5676	3K2022021	
C-62		N16-C-28557-9050	3K1510121	
C-63		N16-C-27080-7650	3K1527021	3330-055950346
C-64		N16-C-63934-1117	3D9012V-36	3330-058220056
C-65		Same as C-1		
C-66		N16-C-27370-9050	3K1539031	3330-055950347
C-67		Same as C-1		
C-68		N16-C-28979-9400	3K1515131	3330-055950348
C-69		N16-C-31670-6969	3K3018231	
C-70		N16-C-33279-6028	3K3582231	
C-71A, B, C		N16-C-22483-4305	3DB20-202	3330-055225330
C-72		N16-C-28816-8196	3K2013122	
C-73		N16-C-30114-4276	3K2047121	
C-74		Same as C-36		
C-75		N16-C-31908-1564	3K3022221	
C-76		Same as C-70		
C-77		Same as C-49		
C-78		N16-C-19556-4640	3DB10-269	3330-055725-008
C-79		Same as C-49		
C-80		Same as C-11		
C-81		N16-C-32720-7528	3K35512222	
C-82		N16-C-19716-3041	3DB20-199	
C-83		N16-C-25049-8296	3D9004E7-8	3330-056200941
C-84		Same as C-78		
C-85		N16-C-19567-2065	3DB10-268	3330-055725012
C-86		N16-C-63965-2800	3D9013V-10	
C-87		N16-C-26606-2076	3K2018021	
C-88		Same as C-53		
C-89		Same as C-81		
C-90		N16-C-44299-4526		3330-057252623
C-91		N16-C-47248-3641	3DA500-931	3330-057252594
C-92		* N16-C-30188-3635	3K1551122	
C-93		Same as C-15		
C-94		Same as C-36		
C-95		Same as C-11		
C-96		Same as C-1		
C-97		N16-C-27766-7676	3K2056021	
C-98		Same as C-53		
C-99		N16-C-44112-3301	3DA47-64	3330-057252836
C-100		Same as C-15		
C-101		N16-C-18982-6870	3DA4.700-28	3330-055412500
C-102		Same as C-53		
C-103A, B		N16-C-021824-7596		
C-104		N16-C-15537-5001		
CR-1		N17-R051052-4012	3H4860-448	3370-680100-1332
CR-2		N17-R-51478-9701		
CR-3		Same as CR-2		
DL-1		N16-N057938-6056	7CAC-589770	
DS-1		G17-L-6297	2Z5942	
DS-2		Same as DS-1		
DS-3		Same as DS-1		
DS-4		Same as DS-1		
DS-5		N16-K-700349-997	2Z5822-614	3320-NSL
DS-6		N16-K-700538-551	2Z5822-648	3320-NSL
DS-7				3320-080151242
E-1		N17-P-69135-7720	2Z7259-154	
E-2				
E-3		Same as E-2		
E-4		Same as E-1		
E-5		Same as E-1		
E-6		N17-B-88403-3356	3H525W-8	
E-6A				1660-348050100
E-7		N16-S-35011-3814	2Z8304.300	3300-028700000

*Asterisks apply to replacement items which differ from the original item supplied in the equipment.

TABLE 8—3. STOCK NUMBER IDENTIFICATION—Continued

REF. DESIG.	STOCK NUMBER			
	FEDERAL	STANDARD NAVY	SIGNAL CORPS	AIR FORCE
E-8		N16-S-34890-4712	2Z8304.299	3300-028700005
E-9		N17-C-080895-1225	2Z3193-353	
E-10		Not used		
E-11		N17-C-813511-101	2Z2724-9	8850-157100
E-12		N16-B-151921-0173	2Z7779-179	
E-13		N16-B-151921-137	2Z560-60	3370-0362001939
E-14		N16-S-34576-6514	2Z8304.275	
E-15		N16-S-34520-3864	2Z8304.57	3300-295578675
E-16		N16-S-34557-8351	2Z8304.276	
E-17		N16-R-503580-0451		
E-18		N16-R-503580-0448		
E-19		N16-R-503580-0449		
E-20		N16-R-503580-0450		
F-1		N17-F-16302-130	3Z2604.1	
F-2		Same as F-1		
F-3		Same as F-1		
F-4		Same as F-1		
FL-1		N17-S-51029-2315		3330-058750225
HR-1		N16-R-66030-3886	3RW24324	
J-1		N17-C-73108-1267	2Z7390-185	
J-2		N17-C-72240-1522	2Z3064-16	
J-3		Same as J-1		
J-4		N17-C-73470-1265		
J-5		Same as J-1		
J-6		Same as J-1		
J-7		Same as J-1		
J-8		Same as J-1		
J-9		Same as J-1		
J-10		Same as J-1		
L-1		N16-C-76615-7701	3C1084Z105-3	3340-060701520
L-2		N16-C-074763-7815	3C1084Z105-4	3340-060701510
L-3		N16-C-76645-8155	3C1084Z105-2	3340-060701450
L-4		Same as L-3		
L-5		N16-C-76621-1369	3C1084Z105-4	
L-6		Same as L-2		
L-7		N16-R-29091-8066	3C554C-1	3340-062450230
L-8		N16-C-072031-6001	3C1084Z105-8	3340-060717750
L-9		N16-C-072113-1002	3C1084Z105-7	3340-060717610
L-10		N16-C-3074027-8631	3C1084Z105-6	3340-060717760
L-11		N16-C-072246-6002	3C1084Z105-5	3340-060717620
L-12		Same as L-10		
L-13		N16-C-75160-5001	3C1084Z105-1	3340-060701500
L-14		Same as L-13		
L-15		N16-C-074075-4620		
L-16		Same as L-15		
L-17		N16-C-075089-4194		
MP-1		N17-S-036816-1050	2ZA951-57	7CWU-NSL
MP-2				
MP-3				
MP-4				
MP-5				
MP-6			2Z3295-270	3330-058570016
MP-7		N16-B-800200-566	2Z8552-104	
MP-8				
MP-9		N17-C-789978-0721	2Z2646.253	
MP-10		N17-C-781241-292	2Z2642.547	3330-NSL
MP-11		N17-C-789978-0722	2Z2646.252	
MP-12		N16-R-503580-0472		
MP-13		N17-C-782034-101		
MP-14		N17-B-077509-1682		
MP-15				
N-1			2Z8076-184	7CWU-NSL
N-2		N17-F-39601-1153	3F31250-1	7CWU-IPC013-001
R-1		N16-R-73244-1292	3Z6730-68	

TABLE 8—3. STOCK NUMBER IDENTIFICATION—Continued

REF. DESIG.	STOCK NUMBER			
	FEDERAL	STANDARD NAVY	SIGNAL CORPS	AIR FORCE
R-2		N16-R-73241-5986	3Z6729G7-3	
R-3		N16-R-73236-6382	3Z6729-5	
R-4		N16-R-73234-2051	3Z6727-50	3350-385300-7485
R-5		N16-R-73219-3351	3RN62007	3350-385300-7465
R-6		* N16-R-72993-5904	3RN41014	3350-382000-24525
R-7		* N16-R-73023-2604	3Z6300-263	
R-8		* N16-R-73092-6518		3350-382000-26695
R-9		* N16-R-73124-8535	3Z6630-137	
R-10		* N16-R-73192-7246	3RN61015	3350-382000-29977
R-11		N16-R-73248-9851	3RN63403	3350-395300-7545
R-12		N16-R-51065-818	3RC20GF225K	
R-13		N16-R-49427-730	3RC20GF470K	
R-14		N16-R-49940-816	3RC20GF122K	
R-15		N16-R-50497-761	3RC32GF513J	
R-16		N16-R-49561-438	3RC20GF910J	
R-17		N16-R-50417-823	3RC20GF333K	
R-18		N16-R-51020-818	3RC20GF155K	
R-19		N16-R-50129-815	3RC20GF472K	
R-20		N16-R-49786-438	3RC20GF511J	
R-21		N16-R-50283-116	3RC32GF103K	
R-22		N16-R-50310-485	3RC42GF123K	
R-23		N16-R-66369-8867		
R-24		N16-R-49733-750	3RC20GF391K	
R-25		N16-R-90754-3352	3Z7310-160	3350-844500-3896
R-26		N16-R-49642-436	3RC20GF181J	
R-27		N16-R-51326-818	3RC20GF106K	
R-28		N16-R-50308-438	3RC20GF123J	
R-29		N16-R-49984-349	3RC20GF182J	
R-30		Same as R-13		
R-31		N16-R-50013-466	3RC42GF222K	
R-32		Same as R-31		
R-33		Same as R-13		
R-34		N16-R-50975-725	3RC20GF105K	
R-35		N16-R-64098-5399	3Z6080-74	3300-066180100
R-36		N16-R-49426-433	3RC32GF470J	
R-37		Same as R-34		
R-38		Same as R-13		
R-39		N16-R-49859-131	3RC42GF751J	
R-40		Same as R-39		
R-41		N16-R-50165-818	3RC20GF562K	
R-42		Same as R-13		
R-43		Same as R-13		
R-44		Same as R-31		
R-45		Same as R-41		
R-46		N16-R-49904-124	3RC42GF911J	
R-47		Same as R-46		
R-48		Same as R-12		
R-49		Same as R-12		
R-50		N16-R-88080-9340	3Z7498-25.145	3350-759000-5531
R-51A, B		N16-R-89133-1476	3Z7498-50.363	3350-766100-8735
R-52		N16-R-50714-818	3RC20GF224K	
R-53		N16-R-51344-818	3RC20GF126K	
R-54		Same as R-53		
R-55		Same as R-53		
R-56		N16-R-50931-201	3RC32GF824K	
R-57		Same as R-56		
R-58		N16-R-88180-9350	3Z7498-50.179	3350-758900-5951
R-59		N16-R-50859-201	3RC32GF564K	
R-60		N16-R-50633-785	3RC20GF104K	
R-61		N16-R-50040-179	3RC32GF272K	
R-62		N16-R-88061-1115	3Z7498-20.33	3350-758900-5531
R-63		N16-R-50823-206	3RC32GF474K	
R-64		N16-R-50678-818	3RC20GF154K	
R-65		Same as R-52		
R-66		N16-R-88101-1022	3Z7498-30.6	3350-759000-5555
R-67		N16-R-50759-818	3RC20GF334K	

*Asterisks apply to replacement items which differ from the original item supplied in the equipment.

TABLE 8—3. STOCK NUMBER IDENTIFICATION—Continued

REF. DESIG.	STOCK NUMBER			
	FEDERAL	STANDARD NAVY	SIGNAL CORPS	AIR FORCE
R-68		N16-R-50479-435	3RC20GF473J	
R-69		N16-R-50587-435	3RC20GF823J	
R-70		N16-R-50992-275	3RC20GF125J	
R-71		N16-R-50335-438	3RC20GF153J	
R-72		N16-R-50283-116	3RC32GF103J	
R-73		Same as R-72		
R-74		Same as R-71		
R-75		Same as R-70		
R-76		N16-R-50066-816	3RC20GF332K	
R-77		N16-R-50650-390	3RC20GF124J	
R-78		N16-R-87680-9444	3Z7410-283	3350-759000-3515
R-79		N16-R-91031-1105	3RA6914	3350-844500-4991
R-80		N16-R-87350-9458	3Z7310-159	3350-759000-2795
R-81		N16-R-50147-112	3RC42GF512J	
R-82		Same as R-81		
R-83		N16-R-49391-818	3RC20GF390K	
R-84		Same as R-83		
R-85		Same as R-83		
R-86		Same as R-83		
R-87		Same as R-83		
R-88		Same as R-83		
R-89		Same as R-83		
R-90		Same as R-83		
R-91		N16-R-49985-131	3RC42GF182J	
R-92		Same as R-91		
R-93		Same as R-63		
R-94		N16-R-50839-438	3RC20GF514J	
R-95		N16-R-68278-9869	3RU08004	3350-4540001663
R-96		Same as R-95		
R-97		* N16-R-49363-438	3RC20GF330K	
R-98		N16-R-89858-8294	3Z7035-4	3350-844500-1784
R-99		N16-R-50749-438	3RC20GF304J	
R-100		N16-R-50282-725	3RC20GF103K	
R-101		N16-R-50039-721	3RC20GF272K	
R-102		N16-R-49463-818	3RC20GF560K	
R-103		Same as R-34		
R-104		Same as R-24		
R-105		N16-R-49769-799	3RC20GF471K	
R-106		N16-R-87397-8321	2ZK7296-2M.4	3350-759000-2921
R-107		Same as R-34		
R-108		N16-R-49669-438	3RC20GF241J	
R-109		Same as R-105		
R-110		N16-R-50012-816	3RC20GF222K	
R-111		Same as R-34		
R-112		N16-R-49968-209	3RC32GF152K	
R-113		N16-R-50371-433	3RC20GF223J	
R-114		N16-R-49922-730	3RC20GF102K	
R-115		Same as R-61		
R-116		N16-R-50308-716	3RC32GF123J	
R-117		Same as R-102		
R-118		N16-R-50353-945	3RC42GF183J	
R-119		Same as R-100		
R-120A, B		N16-R-69215-1288	3Z7499-1.197	3350-766100-8791
R-121		Same as R-102		
R-122		N16-R-50166-512	3RC42GF562K	
R-123		N16-R-50696-818	3RC20GF184K	
R-124		Same as R-52		
R-125		N16-R-50479-440	3RC20GF473K	
R-126		N16-R-88007-8780	3Z7480-278	3350-759000-4715
R-127		N16-R-88007-8522	3Z7480-277	3350-759000-4723
R-128		N16-R-50956-433	3RC20GF914J	
R-129		Same as R-34		
R-130		N16-R-88340-9659	3Z7499-1.196	3350-759000-6485
R-131		Same as R-71		
R-132		N16-R-50263-438	3RC20GF912J	
R-133		N16-R-068408-6731	3RW26119	

*Asterisks apply to replacement items which differ from the original item supplied in the equipment.

TABLE 8—3. STOCK NUMBER IDENTIFICATION—Continued

REF. DESIG.	STOCK NUMBER			
	FEDERAL	STANDARD NAVY	SIGNAL CORPS	AIR FORCE
R-134		N16-R-50651-818	3RC20GF124K	
R-135		N16-R-87750-9321	3Z7425-183	3350-759000-4125
R-136		Same as R-76		
R-137		N16-R-49923-171	3RC32GF102K	
R-138		Same as R-100		
R-139			3RN41008	3350-385300-4716
R-140		* N16-R-72961-4246	3Z6056-39	3350-382000-2288
R-141		N16-R-88010-9312	3Z7480-276	3350-759000-4995
R-142		Same as R-141		
R-143		* N16-R-50443-438	3RC20GF393K	
R-144		* N16-R-73053-1651	3Z6556-2	3350-382000-25823
R-145		Same as R-100		
R-146		* N16-R-72943-2674	3Z6039-25	3350-383600-13158
R-147		* N16-R-72961-6979	3Z6056-40	3350-385300-4446
R-148		N16-R-49841-818	3RC20GF681K	
R-149		N16-R-50372-833	3RC20GF223K	
R-150		N16-R-50516-818	3RC20GF563K	
R-151		N16-R-50400-511	3RC42GF273K	
R-152		Same as R-14		
R-153		N16-R-50335-656	3RC32GF153J	
R-154		Same as R-100		
R-155		Same as R-13		
R-156		Same as R-24		
R-157		N16-R-49598-818	3RC20GF121K	
R-158		Same as R-157		
R-159		N16-R-49579-131	3RC20GF101J	
R-160		N16-R-49300-438	3RC20GF180J	
R-161		* N16-R-73328-9401	3Z5992-102	3350-382000-69998
R-162		* N16-R-73247-1981	3Z6733C3-3	3350-382000-41153
R-163		* N16-R-73196-3776		3350-382000-32895
R-164		* N16-R-73139-7352	3Z6640-117	3350-383600-3115
R-165		Same as R-8		
R-166		Same as R-8		
R-167		Same as R-64		
R-168		N16-R-88060-9622	3Z7498-20.49	3350-759000-5285
R-169		N16-R-50373-423	3RC42GF223K	
R-170		Same as R-41		
R-171		N16-R-50911-438	3RC20GF754J	
R-172		N16-R-50974-438	3RC20GF115J	
R-173		N16-R-50445-503	3RC42GF393K	
R-174		Same as R-14		
R-175		Same as R-143		
R-176		N16-R-50399-813	3RC20GF273K	
R-177		Same as R-100		
R-178		N16-R-50013-466	3RC32GF222K	
R-179		N16-R-50166-167	3RC32GF562J	
R-180		N16-R-50183-131	3RC42GF622J	
R-181		Same as R-12		
R-182		N16-R-49877-818	3RC20GF821K	
R-183		N16-R-50317-437	3RC20GF133J	
R-184		N16-R-50481-461	3RC42GF473K	
R-185		Same as R-34		
R-186		Same as R-50		
R-187		N16-R-087847-8783		3350-759000-4293
R-188		Not used		
R-189		N16-R-51173-818	3RC20GF475K	
R-190		Same as R-18		
R-191		N16-R-50337-518	3RC42GF153K	
R-192		N16-R-50202-107	3RC32GF682K	
R-193		N16-R-87748-7690	3Z7425-181	3350-759000-3943
R-194		N16-R-49985-813	3RC20GF182K	
R-195		Same as R-27		
R-196		N16-R-87747-8235	3Z7425-185	3350-759000-39425
R-197		Same as R-60		
R-198		N16-R-51209-818	3RC20GF565K	
R-199		Same as R-191		
R-200		Same as R-191		

*Asterisks apply to replacement items which differ from the original item supplied in the equipment.

TABLE 8—3. STOCK NUMBER IDENTIFICATION—Continued

REF. DESIG.	STOCK NUMBER			
	FEDERAL	STANDARD NAVY	SIGNAL CORPS	AIR FORCE
R-201		N16-R-50219-131	3RC42GF752J	
R-202		Same as R-201		
R-203		Same as R-191		
R-204		Same as R-169		
R-205		Same as R-12		
R-206		N16-R-49688-746	3RC20GF271K	
R-207		Same as R-60		
R-208		Same as R-60		
R-209		Same as R-135		
R-210		Same as R-108		
R-211		N16-R-49122-271	3RC32GF5R6K	
R-212		Same as R-157		
R-213		Same as R-13		
R-214		Same as R-13		
R-215		Same as R-23		
R-216		N16-R-50679-522	3RC42GF154K	
R-217		N16-R-50894-811	3RC20GF684K	
R-218		Same as R-41		
R-219		Same as R-176		
S-1		N17-S-64602-6601	3Z9825-48.11	3360-073114231
S-2		N17-S-60226-5386	3Z9825-48.12	3360-073114542
S-3		N17-S-69689-1649		
S-4		N17-S-69869-5582	3Z9695-17.11	3360-073940-300
S-5		N17-S-74692-4506	3Z9863-52P	
S-6		N17-S-56835-4746	3Z9812-7.4	3360-073012840
S-7		N17-S-56835-4736	3Z9812-7.5	3360-073012838
S-8		N17-S-59931-7431	3Z9825-62.835	3360-073114528
S-9		Part of R-98		
S-10		N17-S-60128-8559	3Z9825-62.830	3360-073114544
S-11		N17-S-61164-5255	3Z9825-48.13	3360-073114530
S-12		Part of R-126		
S-13		N17-S-66211-6061	3Z9825-62.832	3360-073114543
S-14		N17-S-64591-9387	3Z9825-62.834	3360-073114545
S-15		N17-S-62010-4561	3Z9825-62.833	3360-073114546
T-1		N17-T-73601-1011	2Z9621-389	3340-063900-280
T-2		N17-T-79559-7713	2Z9627-188	3340-064050-130
TB-1				
TB-2				
TB-3				
TB-4				
TB-5				
TB-6				
TB-7				
TB-8				
TB-9				
TB-10				
TB-11				
TB-12				
TB-13				
TB-14				
TB-15				
TB-16				
V-1		N16-T-56185	2J6AH6	
V-2A, B		N16-T-58241	2J12AU7	
V-3		Same as V-1		
V-4		N16-T-56196-50	2J6AN5WA	
V-5		Same as V-4		
V-6		N16-T-53735	2J3JP1	3370-250000-4575
V-7A, B		Same as V-2		
V-8		N16-T-76203	2J6203	3370-259000-6213
V-9		Same as V-8		
V-10		Same as V-8		
V-11		Same as V-8		
V-12		N16-T-51981	2J1V2	3370-NSL
V-13		Same as V-12		
V-14A, B		N16-T-58240-14	2J12AT7WA	
V-15A, B		N16-T-75726	2J5726/6AL5W	

TABLE 8—3. STOCK NUMBER IDENTIFICATION—Continued

REF. DESIG.	STOCK NUMBER			
	FEDERAL	STANDARD NAVY	SIGNAL CORPS	AIR FORCE
V-16A, B		Same as V-14		
V-17A, B		Same as V-2		
V-18A, B		Same as V-14		
V-19		N16-T-52001-3	2J0A2WA	
V-20		N16-T-76135	2J6135	
V-21A, B		Same as V-14		
V-22		Same as V-1		
V-23A, B		Same as V-2		
V-24		Same as V-20		
V-25A, B		Same as V-15		
V-26A, B		Same as V-2		
V-27A, B		Same as V-14		
V-28A, B		Same as V-14		
V-29A, B		Same as V-2		
XDS-1		N17-L-051206-9551		7700-539006
XDS-1A		* N17-L-250177-226		
XDS-2				7700-539016
XDS-2A		* N17-L-250627-691		
XDS-3		N17-L-51625-1255	2Z5882-79	
XDS-4		Same as XDS-3		
XF-1		N17-F-74266-9053	3Z3282-11.28	
XF-2		Same as XF-1		
XF-3		Same as XF-1		
XF-4		Same as XF-1		
XV-1			2Z8677.277	8850-881717
XV-2		N16-S-64063-6230	2Z8679.87	8850-896722
XV-3		Same as XV-1		
XV-4		Same as XV-1		
XV-5		Same as XV-1		
XV-6		N16-S-64378-3687	2Z8684-45	8850-897099
XV-7		Same as XV-2		
XV-8		Same as XV-2		
XV-9		Same as XV-2		
XV-10		Same as XV-2		
XV-11		Same as XV-2		
XV-12				8850-896720
XV-13		Same as XV-12		
XV-14			2Z8679.88	8850-896723
XV-15		N16-S-62603-6924		
XV-16		Same as XV-2		
XV-17		Same as XV-2		
XV-18		Same as XV-2		
XV-19		Same as XV-15		
XV-20		Same as XV-15		
XV-21		Same as XV-12		
XV-22		Same as XV-15		
XV-23		Same as XV-2		
XV-24		Same as XV-15		
XV-25		Same as XV-15		
XV-26		Same as XV-2		
XV-27		Same as XV-2		
XV-28		Same as XV-2		
XV-29		Same as XV-2		
Z-1		N16-0080201-2002	3F3648-7.3	
Z-2		N16-0080201-2003	3F3648-7	
Z-3		N16-0080201-2004	3F3648-7.1	
Z-4		N16-0080201-2005	3F3648-7.2	
A-301			7CAC-226500	
C-301				
C-302		Same as C-101		
C-303		Same as C-101		
C-304		N16-C-025097-5803		
E-301		N17-C-67989-1323	2E308-255	
E-302		N17-C-71415-6313	2Z308-924	8850-151794
E-303		N17-C-68721-9579	2Z308-274	8850-102005
E-304		N17-C-67988-5260	2Z308-273	8850-102000
E-305			2Z308-201	8850-010951

*Asterisks apply to replacement items which differ from the original item supplied in the equipment.

TABLE 8—3. STOCK NUMBER IDENTIFICATION—Continued

REF. DESIG.	STOCK NUMBER			
	FEDERAL	STANDARD NAVY	SIGNAL CORPS	AIR FORCE
E-306			2Z308-349	
H-301		G41-W-2445-2		
H-302		G41-W-2446-2		
H-303		G41-W-2444-5		
H-304		N41-W-3727-850		
L-301		N16-C-72849-4001		3340-060718390
P-301		N17-C-71408-3425	2Z7390-260	8850-469685
P-302		N17-C-70588-1524	2Z7113.35	8850-264044-52
P-303		Same as P-301		
P-304			2Z7390-88	8850-468450
P-305		Same as P-304		
P-306		N17-C-71131-2960	6Z7591-4.1	8850-247230
R-301		N16-R-73337-5863	3Z6802G7-5	3350-383600-5553
R-302		Same as R-105		
R-303		Same as R-34		
R-304		Same as R-148		
R-305		Same as R-105		
V-301		N16-T-75719	2J5719	
W-301		N16-C-11945-2214	1F430-409.96	
W-302		N17-C-48682-8954	3E5999-16.26	
W-303		N17-L-63201-4880		7CAC-468904-115
W-304		N17-L-63201-4029		

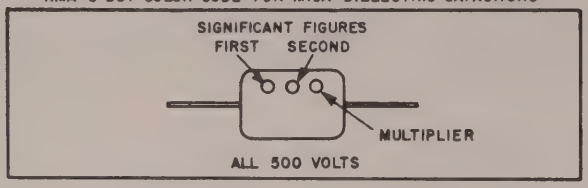
TABLE 8—4. LIST OF MANUFACTURERS

ABBREVIATION	PREFIX	NAME	ADDRESS
AB	CBZ	Allen-Bradley Co.	Milwaukee, Wis.
ALN	CAYT	Allen Manufacturing Co.	Hartford, Conn.
AMP	CPH	American Phenolic Co.	Chicago, Ill.
CRLI	CBN	Central Radio Laboratories, Inc.	Milwaukee, Wis.
CPH	CTC	Chicago Telephone Supply Co.	Elkhart, Ind.
CIN	CMG	Cinch Manufacturing Co.	Chicago, Ill.
CRL	CMC	Clarostat Manufacturing Co.	Dover, N.H.
CPW		Commercial Plastic Co.	Chicago, Ill.
COPC	CAIG	Condenser Products Co.	Chicago, Ill.
CPT		Croname, Incorporated	Chicago, Ill.
CUT	CAE	Cutler Hammer, Inc.	Milwaukee, Wis.
DHM		Harry Davies Molding Co.	Chicago, Ill.
DLC	CAYZ	Dial Light Corporation	New York, N. Y.
DMC	CAYS	Drake Manufacturing Co.	Chicago, Ill.
EBY	CEB	Hugh H. Eby	Philadelphia, Pa.
EMM	CMF	Electro Motive Manufacturing Company	Willimantic, Conn.
ERC	CER	Erie Resistor Corporation	Erie, Pa.
FDR	CFT	Federal Telephone & Radio Corporation	Clifton, N. J.
GLEC		General Electric Company, Lamp Division	Cleveland, Ohio
HAW	CHU	Harvey Hubbell, Inc.	Bridgeport, Conn.
IPC	CARO	Industrial Products Co.	Danbury, Conn.
JON	CEJ	E. F. Johnson Company	Waseea, Minn.
LTF	CLF	Littlefuse, Incorporated	Desplaines, Ill.
MAL	CMA	P. R. Mallory Co., Inc.	Indianapolis, Ind.
OAK	COC	Oak Manufacturing Co.	Chicago, Ill.
PBN		Paul & Beekman, Inc.	Philadelphia, Pa.
SPR	CSF	Sprague Electric Co.	North Adams, Mass.
STMF	CBNU	Stevens Manufacturing Co.	Mansfield, Ohio
SFN	CSJ	Stupakoff Ceramic & Mfg. Co.	Latrobe, Pa.
TBD	CTD	Tobe—Deutschmann Corp.	Norwood, Mass.
WPD	CAGX	Waterman Products Co., Inc.	Philadelphia, Pa.
WECK		Weckesser Company	Chicago, Ill.
WCO	CWC	Wirt Company	Philadelphia, Pa.
TTM		Torrington Manufacturing Co.	Torrington, Conn.
DAB		Delco Appliance Division, General Motors Corp.	Rochester, N. Y.

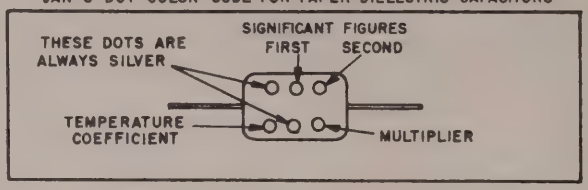
TABLE 8—5. APPLICABLE COLOR CODES AND MISCELLANEOUS DATA

CAPACITOR COLOR CODE

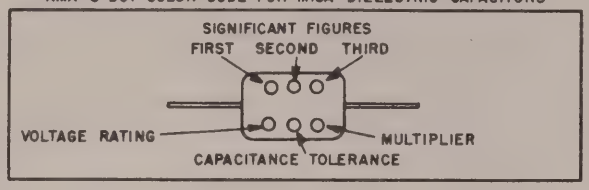
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



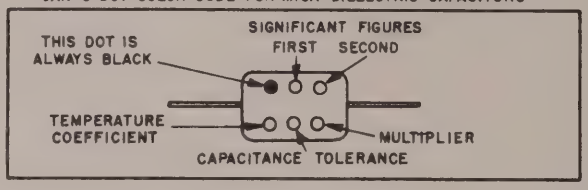
JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



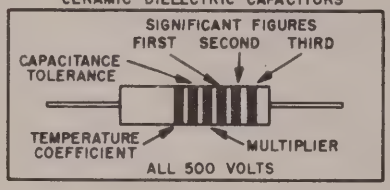
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

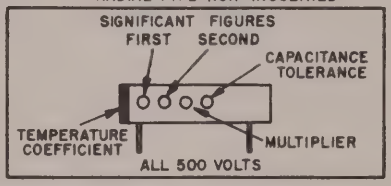


RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS

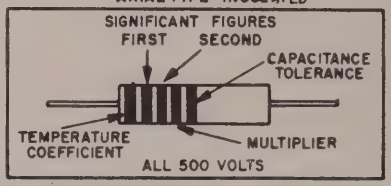


JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

RADIAL TYPE NON-INSULATED



AXIAL TYPE INSULATED



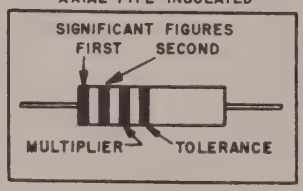
RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

RESISTORS				CAPACITORS				
				MULTIPLIER				
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC	VOLTAGE RATING	TEMPERATURE COEFFICIENT
	1	0	BLACK	1	1	1	100	A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1,000	3	ORANGE	1,000	1,000	1,000	300	D
	10,000	4	YELLOW	10,000			400	E
	100,000	5	GREEN	100,000			500	F
	1,000,000	6	BLUE	1,000,000			600	G
	10,000,000	7	VIOLET	10,000,000			700	
	100,000,000	8	GRAY	100,000,000		0.01	800	
	1,000,000,000	9	WHITE	1,000,000,000		0.1	900	
5	0.1		GOLD	0.1	0.1		1,000	
10	0.01		SILVER	0.01	0.01		2,000	
20			NO COLOR				500	

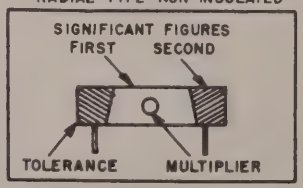
RESISTOR COLOR CODE

JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED

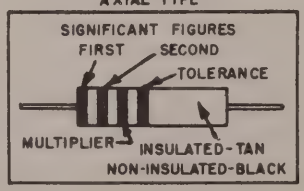


RADIAL TYPE NON INSULATED

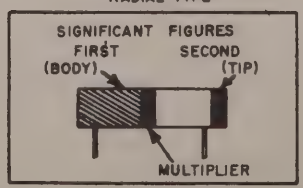


RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE



RADIAL TYPE



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